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FINAL SUMMARY REPORT

OPTIMIZATION AND EVALUATION OF
 ELECTROPHORETIC PROTECTIVE
 COATINGS FOR TANTALUM T-222 ALLOY

By

S. J. Klach and M. H. Ortner

December, 1967

Prepared for

National Aeronautics and Space Administration

Contract NAS 3-9405

R. E. Oldrieve - Project Manager
 S. J. Grisaffe - Research Advisor

NASA Lewis Research Center
 Cleveland, Ohio 44135

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WEST ORANGE LABORATORY • 200 Pleasant Valley Way, West Orange, N. J.

OPTIMIZATION AND EVALUATION OF
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COATINGS FOR TANTALUM T-222 ALLOY

ABSTRACT

Coating process parameters including composition, siliconization time, pre-oxidation time and temperature, and double versus single layer coatings were evaluated during this program in order to improve the oxidation resistance and coating reliability of a variety of silicide coating systems. The coatings were evaluated in terms of oxidation life at 1500°F and 2400°F under cyclic conditions.

The most promising systems developed under this program consisted of either MoSi₂-20TiSi₂ or MoSi₂-40CrSi₂ coatings deposited over a VSi₂ barrier layer. These coating systems, at an overall thickness of approximately 2.5 mils, showed the capability of surviving 600 hours exposure at 1500°F and 2400°F under cyclic conditions. In extended testing at 1500°F and 2400°F, the MoSi₂-20TiSi₂/VSi₂ coating system yielded oxidation lives of 1398 hours and 824 hours, respectively. The specimen of the 1398 hour test was still intact after terminating the test program. Ductility after test was lacking, however.

Excellent coating reproducibility was exhibited by the MoSi₂-40CrSi₂/VSi₂ coating system. Eight of the ten specimens tested (4 at each temperature of 1520°F and 2400°F) survived 626 hours of cyclic testing. The excellent performance of these systems is attributed to the oxidation resistance and self-healing capability of the VSi₂ underlayer.

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	1
2. SUMMARY	2
3. EXPERIMENTAL	4
3.1 Materials and Equipment	4
3.1.1 Substrate Material	4
3.1.2 Coating Materials	4
3.1.3 Coating and Testing Equipment	8
3.2 Coating Development	8
3.2.1 Selection of Coating Systems	8
3.2.2 Coating Procedures	15
3.2.3 Optimization of Process Parameters	17
3.3 Coating Evaluation Studies	29
3.3.1 Oxidation Tests of Selected Coating Systems Siliconized for Various Time Intervals	29
3.3.2 Oxidation Tests of Double-Coated Silicide Coating Systems	50
3.3.3 Oxidation Tests of Preoxidized Silicide Coating Systems.	50
3.3.4 Oxidation Tests of a Siliconized Mo-15.4Ti Coating System	65
3.3.5 Oxidation Tests of the CrSi ₂ -20TiSi ₂ and MoSi ₂ -15CrSi ₂ -15VSi ₂ Coating Systems	65
3.3.6 Oxidation Tests of the Quaternary MoSi ₂ - WSi ₂ -TiSi ₂ -VSi ₂ Coating System	73
3.3.7 Oxidation Tests of MoSi ₂ -Base Coatings Over a VSi ₂ Barrier Layer	73
3.3.8 Bend Ductility Tests.	93

TABLE OF CONTENTS (Continued)

	<u>Page</u>
3.3.9 Reliability Tests of the MoSi ₂ -TiSi ₂ / VSi ₂ and MoSi ₂ -CrSi ₂ /VSi ₂ Coating Systems	93
3.3.10 Electron Microprobe Analysis	98
4. CONCLUSIONS	123
5. RECOMMENDATIONS	125
REFERENCES	126
APPENDIX A - Processing Conditions and Oxidation Test Results for Silicide Coated T-222 Specimens	

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
1	Tantalum Alloy T-222 Ingot Analysis	5
2	Tantalum Alloy T-222 Ingot Analysis	6
3	Spectrographic Analysis of Silicide Coating Materials	7
4	Results of Oxidation Tests of Various Mixed Silicide Pellets at 1500°F	14

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1	Electrophoretic Coating Apparatus	9
2	X-Ray Diffraction Traces of WSi_2 , VSi_2 , and WSi_2 -30 VSi_2 Powders	11
3	Typical Coating Failure of MoSi_2 -30 VSi_2 on T-222 After Sintering at 2910°F for 2 Hours Under Argon	16
4	Effect of Sintering Temperature on the Coating Structure of the MoSi_2 -30 VSi_2 Coating System	18
5	Effect of Siliconization Time on Structure of MoSi_2 -10 CrSi_2 Coating on T-222, Sintered at 2910°F	20
6	Effect of Siliconization Time on Structure of MoSi_2 -20 CrSi_2 Coating on T-222, Sintered at 2910°F	21
7	Effect of Siliconization Time on Structure of MoSi_2 -30 CrSi_2 Coating on T-222, Sintered at 2910°F	22
8	Effect of Siliconization Time on Structure of MoSi_2 -10 TiSi_2 Coating on T-222, Sintered at 2910°F	23
9	Effect of Siliconization Time on Structure of MoSi_2 -20 TiSi_2 Coating on T-222, Sintered at 2910°F	24
10	Effect of Siliconization Time on Structure of MoSi_2 -30 TiSi_2 Coating on T-222, Sintered at 2910°F	25
11	Effect of Siliconization Time on Structure of MoSi_2 -10 VSi_2 Coating on T-222, Sintered at 2910°F	26
12	Effect of Siliconization Time on Structure of MoSi_2 -20 VSi_2 Coating on T-222, Sintered at 2910°F	27
13	Effect of Siliconization Time on Structure of MoSi_2 -30 VSi_2 Coating on T-222, Sintered at 3090°F	28
14	MoSi_2 -10 VSi_2 Coated T-222 Specimens Preoxidized at 2910°F for Various Time Intervals.	30
15	MoSi_2 -20 TiSi_2 Coated T-222 Specimens Preoxidized at 2910°F for Various Time Intervals.	31
16	MoSi_2 -30 CrSi_2 Coated T-222 Specimens Preoxidized at 2910°F for Various Time Intervals.	32

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
17	MoSi ₂ -10VSi ₂ , MoSi ₂ -20TiSi ₂ , and MoSi ₂ -30CrSi ₂ Coated T-222 Specimens Preoxidized at 2730°F for 30 Minutes	33
18	MoSi ₂ -30CrSi ₂ Coated T-222 Specimens, Siliconized 16 Hours and Preoxidized at 2910°F for Various Time Intervals	34
19	Structure of the MoSi ₂ -10VSi ₂ , MoSi ₂ -20TiSi ₂ and MoSi ₂ -30CrSi ₂ Coating Systems Applied as a Double Coating on T-222	35
20	Specimen Arrangement - 1500°F Oxidation Test	36
21	Specimen Arrangement - 2400°F Oxidation Test	37
22	Cyclic Oxidation Test Results at 1500°F of the Various MoSi ₂ -Base Coating Systems Siliconized for Various Time Intervals	39
23	Cyclic Oxidation Test Results at 2400°F of the Various MoSi ₂ -Base Coating Systems Siliconized for Various Time Intervals	40
24	MoSi ₂ -10CrSi ₂ Coated T-222 Specimens Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F.	41
25	MoSi ₂ -20CrSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	42
26	MoSi ₂ -30CrSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	43
27	MoSi ₂ -10TiSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	44
28	MoSi ₂ -20TiSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	45

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
29	MoSi ₂ -30TiSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	46
30	MoSi ₂ -10VSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	47
31	MoSi ₂ -20VSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	48
32	MoSi ₂ -30VSi ₂ Coated T-222, Siliconized for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	49
33	Cyclic Oxidation Test Results of the MoSi ₂ -10VSi ₂ , MoSi ₂ -20TiSi ₂ and MoSi ₂ -30CrSi ₂ Double Coated T-222 Specimens Siliconized for 8 Hours	51
34	MoSi ₂ -10VSi ₂ Double Coated T-222 Specimens Siliconized for 8 Hours and Cyclic Oxidation Tested at 1500°F and 2400°F.	52
35	MoSi ₂ -20TiSi ₂ Double Coated T-222 Specimens Siliconized for 8 Hours and Cyclic Oxidation Tested at 1500°F and 2400°F.	53
36	MoSi ₂ -30CrSi ₂ Double Coated T-222 Specimens Siliconized for 8 Hours and Cyclic Oxidation Tested at 1500°F and 2400°F.	54
37	Cyclic Oxidation Test Results at 1500°F of the Various Silicide Coated T-222 Specimens Pre-oxidized at 2730°F and 2910°F for Various Time Intervals	56
38	Cyclic Oxidation Test Results at 2400°F of the Various Silicide Coated T-222 Specimens Pre-oxidized at 2730°F and 2910°F for Various Time Intervals	57
39	MoSi ₂ -10VSi ₂ Coated T-222 Preoxidized at 2910°F for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	58

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
40	MoSi ₂ -20TiSi ₂ Coated T-222 Preoxidized at 2910°F for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	59
41	MoSi ₂ -30CrSi ₂ Coated T-222 Preoxidized at 2910°F for Various Time Intervals and Cyclic Oxidation Tested at 1500°F and 2400°F	60
42	MoSi ₂ -10VSi ₂ Coated T-222 Preoxidized at 2730°F for 30 Minutes and Cyclic Oxidation Tested at 1500°F and 2400°F	61
43	MoSi ₂ -20TiSi ₂ Coated T-222 Preoxidized at 2730°F for 30 Minutes and Cyclic Oxidation Tested at 1500°F and 2400°F	62
44	MoSi ₂ -30CrSi ₂ Coated T-222 Preoxidized at 2730°F for 30 Minutes and Cyclic Oxidation Tested at 1500°F and 2400°F	63
45	MoSi ₂ -30CrSi ₂ Coated T-222 Specimens Siliconized for 16 Hours, Preoxidized at 2910°F for Various Time Intervals, and Cyclic Oxidation Tested at 1500°F and 2400°F	64
46	Cyclic Oxidation Test Results of the CrSi ₂ -20VSi ₂ , MoSi ₂ -15CrSi ₂ -15VSi ₂ and the Mo-15.4Ti-Si Coated T-222 Specimens	66
47	Mo-15.4Ti Coated T-222 Specimens, Sintered at 3630°F, Siliconized for 16 Hours and Cyclic Oxidation Tested at 1500°F and 2400°F	67
48	Mo-15.4Ti Coated T-222 Specimens, Sintered at 2910°F, Siliconized for 16 Hours and Cyclic Oxidation Tested at 1500°F and 2400°F	68
49	Mo-15.4Ti Coated T-222 Specimens, Sintered at 2910°F and 3630°F Under Reduced Pressure	69
50	Mo-15.4Ti Coated T-222 Specimens, Sintered at 2910°F and 3630°F, and Siliconized for 16 Hours at 2370°F Under Reduced Pressure	70

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
51	CrSi ₂ -20VSi ₂ Coated T-222 Specimens, Sintered at 2910°F and Siliconized at 2370°F for 8 Hours Under Reduced Pressure	71
52	MoSi ₂ -15CrSi ₂ -15VSi ₂ Coated T-222 Specimens, Sintered at 2910°F and Siliconized at 2370°F for 8 Hours Under Reduced Pressure	72
53	CrSi ₂ -20VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F.	74
54	MoSi ₂ -15CrSi ₂ -15VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	75
55	Oxidation Test Results of the MoSi ₂ -WSi ₂ -TiSi ₂ -VSi ₂ Coatings on T-222 at 1500°F and 2400°F Under Cyclic Conditions	76
56	Sintered and Siliconized MoSi ₂ -WSi ₂ -TiSi ₂ -VSi ₂ Coated T-222 Specimens	77
57	35MoSi ₂ -35WSi ₂ -15TiSi ₂ -15VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	78
58	33.6MoSi ₂ -27.6WSi ₂ -19.7TiSi ₂ -19.1VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	79
59	MoSi ₂ -30CrSi ₂ /VSi ₂ Coated T-222 Specimens Sintered at 2910°F and Siliconized at 2370°F for 8 Hours Under Reduced Pressure	81
60	Cyclic Oxidation Test Results of the MoSi ₂ -30CrSi ₂ /VSi ₂ Coated T-222 Specimens	82
61	MoSi ₂ -30CrSi ₂ /VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	83
62	MoSi ₂ -30CrSi ₂ /VSi ₂ Coated T-222 Specimen Cyclic Oxidation Tested at 1500°F and 2400°F	84
63	Sintered and Siliconized MoSi ₂ -20TiSi ₂ /VSi ₂ Coated T-222 Specimens	86

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
64	Sintered and Siliconized MoSi ₂ -40CrSi ₂ /VSi ₂ Coated T-222 Specimens	87
65	Oxidation Test Results of the Various MoSi ₂ -Base/ VSi ₂ Coatings on T-222 at 1500°F and 2400°F Under Cyclic Conditions	88
66	MoSi ₂ -20TiSi ₂ /0.5 mil VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	89
67	MoSi ₂ -20TiSi ₂ /1.5 mil VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	90
68	MoSi ₂ -40CrSi ₂ /0.5 mil VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	91
69	MoSi ₂ -40CrSi ₂ /1.5 mil VSi ₂ Coated T-222 Specimens Cyclic Oxidation Tested at 1500°F and 2400°F	92
70	MoSi ₂ -20TiSi ₂ /0.5 mil VSi ₂ Coating on T-222 Cyclic Oxidation Tested at 2400 F for 400 Hours	94
71	MoSi ₂ -40CrSi ₂ /0.5 mil VSi ₂ Coating on T-222 Cyclic Oxidation Tested at 2400°F for 400 Hours	94
72	Bend Test (4t) MoSi ₂ -40CrSi ₂ /0.5 mil VSi ₂ Coated T-222 Specimens Before and After Oxidation at 2400°F	95
73	Bend Test (4t) MoSi ₂ -20TiSi ₂ /0.5 mil VSi ₂ Coated T-222 Specimens Before and After Oxidation at 2400°F	96
74	Cyclic Oxidation Test Results of the MoSi ₂ -20TiSi ₂ / VSi ₂ and MoSi ₂ -40CrSi ₂ /VSi ₂ Coating Systems at 1500°F and 2400°F.	98
75	Photomicrograph of MoSi ₂ -20TiSi ₂ /VSi ₂ on T-222 Before Oxidation (Specimen WO-423-70-5)	100
76	Microprobe Analysis of MoSi ₂ -20TiSi ₂ /VSi ₂ on T-222 Before Oxidation (Specimen WO 423-70-5)	101
77	Scanning X-Ray Images of MoSi ₂ -20TiSi ₂ /VSi ₂ on T-222 Before Oxidation (Specimen WO 423-70-5-R)	102
78	Scanning X-Ray Images of MoSi ₂ -20TiSi ₂ /VSi ₂ on T-222 Before Oxidation (Specimen WO-423-70-5-L)	103

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
79	Photomicrograph of $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO-423-70-8)	104
80	Microprobe Analysis of $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO-423-70-8)	105
81	Scanning X-Ray Images of $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO-423-70-8-R)	106
82	Scanning X-Ray Images of $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO 423-70-8-L)	107
83	Photomicrograph of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 Before Oxidation (Specimen WO-423-76-11).	108
84	Microprobe Analysis of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 Before Oxidation (Specimen WO-423-76-11).	109
85	Scanning X-Ray Images of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 Before Oxidation (Specimen WO-423-76-11-R).	110
86	Scanning X-Ray Images of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 Before Oxidation (Specimen WO-423-76-11-L)	111
87	Photomicrograph of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO-423-76-5)	112
88	Microprobe Analysis of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO-423-76-5)	113
89	Scanning X-Ray Images of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO-423-76-5-R)	114
90	Scanning X-Ray Images of $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ on T-222 After 400 Hour Oxidation Test at 2400°F (Specimen WO-423-76-5-L)	115

LIST OF ILLUSTRATIONS (Continued)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
91	Photomicrograph of 33.6MoSi ₂ -27.6WSi ₂ - 19.7TiSi ₂ -19.1VSi ₂ on T-222 (Specimen WO-423-82-15 Not Oxidized)	116
92	Microprobe Analysis of 33.6MoSi ₂ -27.6WSi ₂ - 19.7TiSi ₂ -19.1VSi ₂ on T-222 (Specimen WO-423-82-15 Not Oxidized)	117
93	Scanning X-Ray Images of 33.6MoSi ₂ -27.6WSi ₂ - 19.7TiSi ₂ -19.1VSi ₂ on T-222 (Specimen WO-423-82-15-R Not Oxidized)	118
94	Scanning X-Ray Images of 33.6MoSi ₂ -27.6WSi ₂ - 19.7TiSi ₂ -19.1VSi ₂ on T-222 (Specimen WO-423-82-15-L Not Oxidized)	119

1. INTRODUCTION

This is the Final Summary Report on Contract NAS 3-9405, covering the period 1 July 1966 through 27 October 1967. This report has been assigned NASA No. CR 72358. The Project Manager and Research Advisor for this program were R. E. Oldrieve and S. J. Grisaffe, respectively, of the NASA Lewis Research Center. Personnel at Vitro contributing to the performance of this program included:

M. H. Ortner	- Program Manager
S. J. Klach	- Project Leader
L. Evans, W. Lee, J. Morlino	- Research Technicians

The ultimate objective of this program was to develop and evaluate coated materials which can operate for 3000 hours as turbine stator vanes in advanced jet engines. The immediate objective of the program under the current contract was the optimization of process parameters and the improvement in high temperature and low temperature reliability of electro-phoretically deposited refractory silicide coatings for tantalum base alloys.

In a previous contract (NAS 3-7613) highly modified silicide-base coatings were developed which showed promise for protecting tantalum alloy from oxidation at 1500°F and 2400°F. The reliability of the systems developed, however, was marginal and efforts under this contract were therefore concentrated in optimizing process parameters and improving the reliability of these silicide coating systems. Originally, the program was designed to be performed in three tasks, as follows:

- Task I - Optimization of Coating Chemistry and Processing Conditions
- Task II - Statistical Evaluation
- Task III - Preparation of Twenty (20) Silicide Coated Wedge-Shaped Specimens for Delivery to the Project Manager.

Toward the end of the program Tasks II and III were deleted from the program in order to further investigate the subject matter of Task I. This report summarizes the Task I effort.

2. SUMMARY

The immediate objectives of this program were to (a) optimize the MoSi_2 -base coating process parameters in order to provide 400 hours protection at 1500°F and 2400°F for tantalum base alloys, and (b) improve the high and low temperature reliability of these silicide coating systems.

Coating parameters such as coating composition, siliconization time, pre-oxidation time and temperature, coating density and double coating vs single coating were evaluated initially. It was determined that coating composition and siliconization time were the only variables which had a favorable effect in improving the oxidation performance of the silicide coating systems investigated. Coating compositions of MoSi_2 -10 VSi_2 , MoSi_2 -20 TiSi_2 , and MoSi_2 -30 CrSi_2 , and a siliconization time of 8 hours at 2370°F under reduced pressure were found to be optimum. The remaining variables (preoxidation time and temperature, coating density and double coating) were found to be ineffective in improving the life or the reliability of the three single-layer binary silicide systems.

Although some improvement in life was noted after optimizing the siliconization time of the three single-layer binary silicide systems, the program goal of 400 hours cyclic life at 1500°F and 2400°F was not achieved. In subsequent experiments, however, the use of a vanadium silicide barrier layer on T-222 alloy, overcoated with either the binary MoSi_2 -20 TiSi_2 or MoSi_2 -40 CrSi_2 systems to a total thickness of approximately 2.5 mil, was found to give excellent protection at both test temperatures. This coating system concept was considered a breakthrough for achieving the desired oxidation life of 400 hours at 1500°F and 2400°F and for improving the reliability of the silicide coating systems.

At 1500°F , oxidation lives of 400 and 1398 hours were realized without failure with the MoSi_2 -40 CrSi_2 / VSi_2 and MoSi_2 -20 TiSi_2 / VSi_2 coating systems, respectively. At 2400°F , 400 and 824 cyclic oxidation hours at temperature were obtained for the respective coating systems. Specimens were cooled in air to room temperature between each cycle.

In subsequent reliability tests conducted at 1500°F and 2400°F , the MoSi_2 -40 CrSi_2 / VSi_2 coating system exhibited very good coating reproducibility. Of ten (10) T-222 specimens tested (5 at each test temperature), nine specimens survived 400 hours of cyclic testing. Four (4) at each test temperature or a total of eight (8) specimens survived 626 hours of cyclic testing without failure.

Reliability tests conducted on the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ coating system (40 specimens) showed poor coating reliability which was in conflict with previously obtained results. Most of the specimens tested (26) failed in less than 30 hours of testing at 1500°F and 2400°F .

Although time did not permit an investigation of the cause of the early failure of the $\text{VSi}_2\text{-MoSi}_2\text{-20TiSi}_2$ reliability specimens, a later check of the experimental data revealed that a new batch of prealloyed powder had been used for this group of specimens, and that the 40 reliability specimens had been inadvertently silicided for 8 hours (Appendix A pages 59 to 66) instead of 16 hours. The longer siliconization time was used in earlier oxidation tests (Appendix A pages 55 to 66) of the same system which resulted in a minimum of 800 hours of cyclic oxidation life at 1500°F and at 2400°F in extended testing.

Bend tests (4t) conducted on $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ and $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ coated T-222 specimens after oxidation testing for 400 hours at 2400°F showed a loss of ductility of the T-222 alloy substrate indicating oxygen contamination during testing. All specimens tested broke at a bend angle of ten degrees or less. The "ductile life" of the coating systems was not determined.

Electron microprobe analysis of the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$, $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$, and $33.6\text{MoSi}_2\text{-27.6WSi}_2\text{-19.7TiSi}_2\text{-19.1VSi}_2$ coating systems showed silicon to be the predominant specie diffusing into the T-222 substrate before and after oxidation testing.

Tantalum diffused, to some degree, into all of the coating systems as a result of the sintering treatment. After oxidation testing, tantalum was found to diffuse completely through the $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ coating while being inhibited in the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ coating system.

3. EXPERIMENTAL

3.1 Materials and Equipment

3.1.1 Substrate Material

The 2 in. x 1 in. x 0.060 in. test specimens used in this program were sheared from T-222 alloy sheet supplied by Wah Chang Corporation. Analyses, identification, and properties of the two lots of tantalum alloy sheet used are listed in Tables 1 and 2. The T-222 alloy sheet of Heat No. 65041 was material that remained from a previous program (Contract NAS 3-7613) and this material was used for preparing specimens for the siliconization study (Section 3.2.3). All other specimens were prepared initially from the T-222 sheet of Heat No. 65070 (Table 2). However, due to a shortage of substrate material toward the end of the program, it was necessary to reclaim specimens from both tantalum lots. The specimens that were reclaimed were those that were rejected before oxidation testing because of coating defects. Reclamation of the defective silicide coated T-222 specimens was achieved by a sandblasting treatment using 60 grit alumina. Removal of the surface silicide coating and the diffusion zone layer by this technique was complete when the surface of the specimen changed from a bright metallic appearance (diffusion zone) to a dull finish (unaffected substrate). Complete removal of the coating by grit blasting was confirmed by metallography.

3.1.2 Coating Material

The silicide powders investigated as candidate coating systems were purchased from Cerac, Inc. with the following specifications:

Specifications for Coating Materials

<u>Material</u>	<u>Specifications</u>
WSi ₂	Minimum Purity 99.5%, -325 mesh powder
MoSi ₂	Minimum Purity 99.5%, -325 mesh powder
TiSi ₂	Minimum Purity 98.8%, -325 mesh powder
VSi ₂	Minimum Purity 99.5%, -325 mesh powder
CrSi ₂	Minimum Purity 99.5%, -325 mesh powder

The spectrographic analyses of these materials are listed in Table 3. These analyses were furnished by the vendor.

TABLE 1

TANTALUM ALLOY T-222 INGOT ANALYSIS
HEAT NO. 65070-T-222

Ingot Analysis, Composition in Percent

	1	2	3	4
Hf	2.7	2.7	2.7	2.4
W	10.3	10.5	10.0	10.4

Ingot Impurities in PPM

Al	< 10	< 10	< 10	< 10
B	< 1	< 1	< 1	< 1
C	100	100	120	100
Cb	800	660	780	900
Co	< 5	< 5	< 5	< 5
Cr	< 10	< 10	< 10	< 10
Cu	< 20	< 20	< 20	< 20
Fe	35	35	35	35
H	2.2			2.4
Mo	30	30	30	40
N	35	50	40	45
Ni	< 10	< 10	< 10	< 10
O	< 50			60
Si	< 20	< 20	< 20	< 20
Ti	< 20	< 20	< 20	< 20
V	< 10	< 10	< 10	< 10

Ingot Hardness in BHN

Average	262
Range	255-269

Final Anneal

1 hr. @ 3000°F

Vacuum of 1×10^{-4} Torr

Product Chemistry in PPM

C	110
O	120
N	10
H	3.3

Product Hardness, DPH

Edge	258
Center	288
Edge	278

Metallography Report

Material is 100% recrystallized

ASTM Grain Size

Sample	
#1	7.5
#2	8

Tensile Test Results @ Room Temp. Trans.

Sample	Tensile Strength	Yield Strength (0.2% Offset)	Elongation % in 1"
#1	121.0 ksi	104.0 ksi	27.0
#2	121.0 ksi	105.0 ksi	26.0

Bend Test Results @ Room Temp.

105° 1T

2 Trans. Acceptable Specimens bent without cracking.

Processing History

1. Forge 7" dia. to 1-1/2" x W x L
2. Anneal
3. Warm Roll 1-1/2" to .250" x W x L
4. Anneal
5. Cold Roll .250" to .062" x W x L
6. Final Anneal

TABLE 2
TANTALUM ALLOY T-222 INGOT ANALYSIS
Heat No. 65041-T222

INGOT ANALYSIS

<u>COMPOSITION IN PERCENT</u>				
Hf	2.9	2.7	2.7	2.4
W	8.8	8.6	9.0	9.4
Ta	88.3	88.7	88.3	88.2
<u>IMPURITY CONTENT, PPM</u>				
Al	<20	<20	<20	<20
C	110	90	110	120
Cb	525	600	590	445
Cd	<5	<5	<5	<5
Co	<10	<10	<10	<10
Cr	<20	<20	<20	<20
Cu	<40	<40	<40	<40
Fe	<40	<40	<40	40
Mg	<20	<20	<20	<20
Mn	<20	<20	<20	<20
Mo	30	40	30	30
N	20	20	25	20
Ni	<20	<20	<20	<20
Pb	<20	<20	<20	<20
Si	<40	<40	<40	<40
Sn	<20	<20	<20	<20
Ti	<50	<50	<50	<50
V	<20	<20	<20	<20
H	3.1			3.2
O	<50			<50

HARDNESS IN BHN

Average 254
Range 248 - 262

PRODUCT CHEMISTRY, PPM

C	180
O	50
N	8
H	2

TENSILE TEST RESULTS AT ROOM TEMPERATURE

<u>Sample</u>	<u>Tensile Strength</u>	<u>Yield Strength (0.2% Offset)</u>	<u>Elongation % in 2"</u>
Long. #1	114,000 psi	102,000 psi	22.5
Long. #2	114,000 psi	101,000 psi	22.5
Trans. #1	117,000 psi	103,000 psi	22.5
Trans. #2	118,000 psi	106,000 psi	21.5

ASTM GRAIN SIZE

7.5

PRODUCT HARDNESS, DPH

<u>Sample</u>	<u>Center</u>	<u>Edge</u>
#1	301	302
#2	309	317

BEND TEST RESULTS AT ROOM TEMPERATURE

Trans. - Acceptable - Samples Bent
Long. - Without Cracking

TABLE 3
SPECTROGRAPHIC ANALYSIS OF
SILICIDE COATING MATERIALS
(Data furnished by Cerac, Inc.)

	<u>CrSi₂</u>	<u>TiSi₂</u>	<u>VSi₂</u>	<u>WSi₂</u>	<u>MoSi₂</u>
Mn	0.01-0.1	0.01-0.1	0.005-0.05	0.001-0.01	0.001-0.01
Ni	0.05-0.5	none	0.01	0.01	0.001-0.01
Cr		none	none	0.05-0.5	0.01-0.1
Mo	0.01-0.1	none	0.1-1.0	0.01	
Cu	0.01	0.01	0.01	0.01	0.01-0.1
V	0.01	none		none	0.001-0.01
Fe	0.1-1.0	0.1-1.0	0.1-1.0	0.1-1.0	0.01-0.1
Al	0.01	0.01	0.01	0.01	0.001-0.01
Mg	0.001	0.001	0.001	0.001	none
Ti	0.01-0.1		0.01-0.1	0.001	0.001-0.01

These raw materials, prior to dispersion preparation, were weighed, mechanically blended in the selected coating composition, and milled for 24 hours in a chromium steel ball mill using isopropanol as the milling medium. The milled powders were leached with dilute hydrochloric acid, washed with distilled water, and dried. The powders were then pelletized, isostatically pressed at 30 tsi and prealloyed at 2910°F for 72 hours under argon. The 72 hour prealloying time was used on the basis of results obtained in the pellet studies described in Section 3.2.1. The prealloyed pellets of each silicide composition were finally crushed to -100 mesh powders and milled again for 24 hours, leached with acid, washed and dried. The resulting (approximately 10 micron) powders were then used to prepare the various electrophoretic dispersions.

3.1.3 Coating and Testing Equipment

The electrophoretic coating equipment used in this program consisted of a stainless steel tank (one pint capacity), a recirculating centrifugal pump, a Hewlett Packard DC power supply (0-500 volt range) and a timer. A schematic drawing of this apparatus is shown in Figure 1.

Sintering and oxidation testing at 2400°F of the electrophoretically applied coating were done in a multi-tube Globar-heated furnace. The temperature of the Globar furnace was indicated by a Pt-6 Rh/Pt-30 Rh thermocouple, and the accuracy of the furnace thermocouple was checked against a standard thermocouple of the same type.

Oxidation tests at the 1500°F test temperature were conducted in a Hevi Duty, 5 inch diameter Hinged Combustion Tube Furnace. The temperature was controlled by a Wheelco Capacitrol Model 292 and indicated by a Pt/Pt-13 Rh thermocouple. Stress relieving the T-222 specimens prior to coating was accomplished in a Brew Vacuum Furnace, Model 1064.

3.2 Coating Development

3.2.1 Selection of Coating Systems

A total of eighteen binary MoSi_2 and WSi_2 -base coating systems containing 10%, 20%, and 30% additions of CrSi_2 , TiSi_2 and VSi_2 were initially selected and screened as potential coating systems for protecting tantalum base alloys from oxidation at 1500°F and 2400°F. These systems were chosen on the basis of results obtained in previous work under Contract NAS 3-7613⁽¹⁾.

⁽¹⁾ See References following body of report.

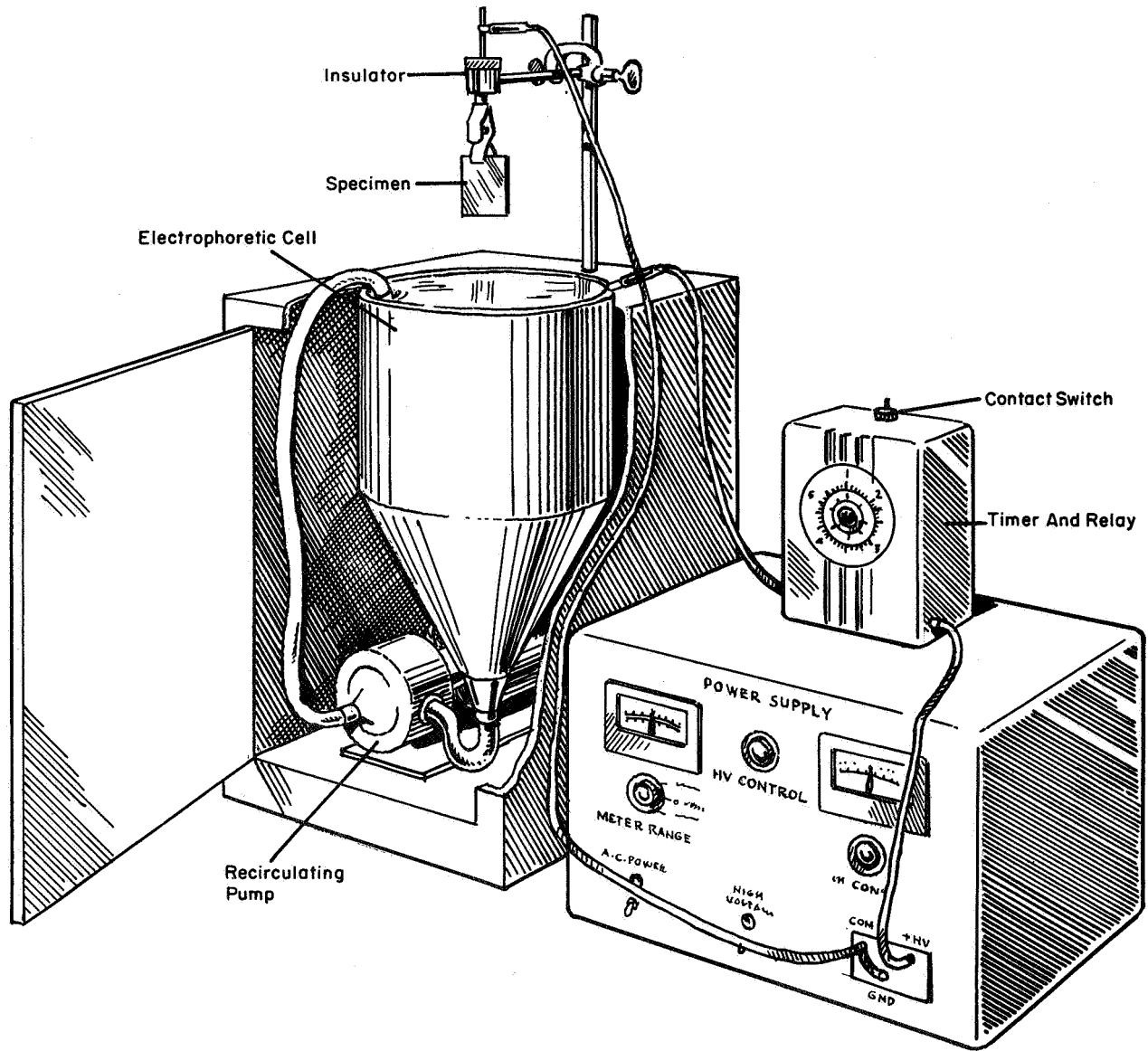


FIGURE 1

ELECTROPHORETIC COATING APPARATUS

The screening of the selected MoSi_2 and WSi_2 -base coating systems was begun by oxidation testing at 1500°F prealloyed pellets of the various silicide combinations to determine their susceptibility to "pest" formation. Prior to testing, however, a preliminary evaluation was made of the use of X-ray diffraction as an analytical tool to determine the extent of solid solubility of the binary silicide coating system as a function of the time and temperature of heat treatment. The X-ray diffraction studies were done by E. F. Fullam, Inc., and the following silicide pellet specimens were examined:

<u>Specimen No.</u>	<u>Description</u>
WO-410-94-1	WSi_2 -30 VSi_2 pellet, densified at 40 tsi, fired in argon at 2730°F for 72 hours
WO-410-94-2	WSi_2 -30 VSi_2 pellet, densified at 40 tsi, fired in argon at 2730°F for 24 hours
WO-410-94-3	WSi_2 pellet, densified at 50 tsi
WO-410-94-4	VSi_2 pellet, densified at 40 tsi
WO-410-94-5	WSi_2 -30 VSi_2 fused fragment

Each of the specimens was ground to -325 mesh powder and examined under identical conditions to allow direct comparison of the results. X-ray diffraction patterns were obtained using the diffractometer at 35 kv and 15 ma with nickel-filtered copper radiation. The original diffraction traces are shown in Figure 2. The following conclusions were drawn from this experiment:

- a) WSi_2 and VSi_2 produce distinctive diffraction patterns that can be readily differentiated.
- b) Diffraction peaks of both WSi_2 and VSi_2 were obtained from the three samples containing WSi_2 with 30% VSi_2 . Therefore complete solid solubility was not obtained in any of the mixtures.
- c) The diffraction peaks for both the WSi_2 and VSi_2 were shifted slightly in the three samples of WSi_2 -30% VSi_2 thereby indicating some solubility of V in WSi_2 and some solubility of W in VSi_2 .
- d) No detectable amounts of phases other than the disilicides were present.

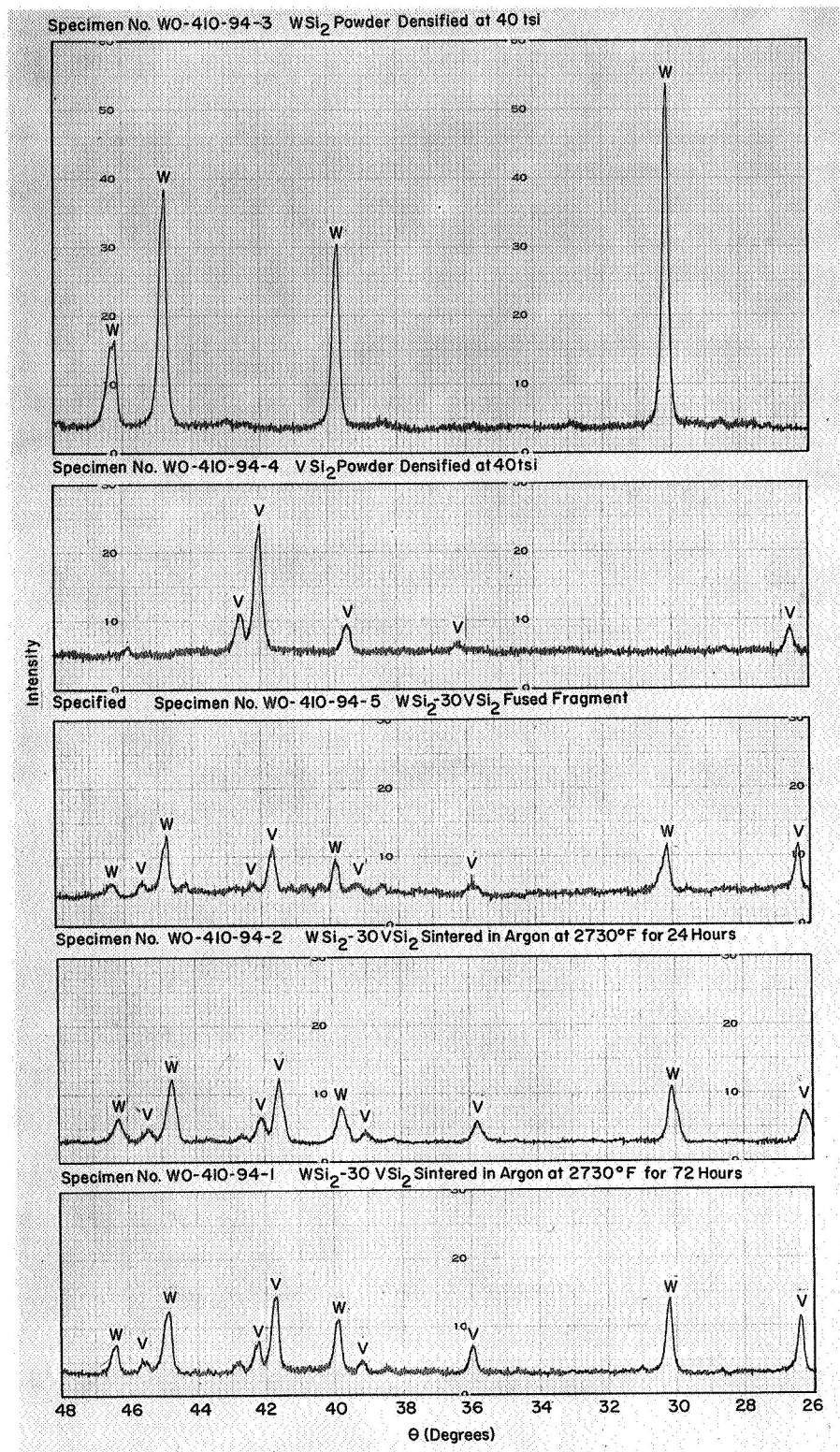


FIGURE 2

X-RAY DIFFRACTION TRACES OF
WSi₂, VSi₂, AND WSi₂-30VSi₂ POWDERS

- e) Comparison of the degree of line shift of the two samples sintered at 2730°F shows a greater line shift after the 24 hour treatment than after the 72 hour treatment. This observation indicates some unknown effect or transformation which is time dependent.
- f) The diffraction peaks of the 72 hour prealloyed sample and the fused fragment appear identical indicating that a 72 hour prealloying time at 2730°F is sufficient to attain the maximum degree of mutual solubility that can be achieved with the WSi₂-VSi₂ system.

At the onset of the X-ray evaluation of solid solubility it was anticipated that all binary silicide systems chosen for coating studies would be analyzed by this technique. However, due to the time consuming nature of this approach, it was decided to utilize the 72 hour prealloying schedule for all the silicide coating combinations earmarked for investigation under this program.

In the pellet oxidation tests at 1500°F for determination of susceptibility to "pest" formation, the following two groups of mixed silicides were prepared and tested:

<u>Group I</u>	<u>Group II</u>
WSi ₂ -10%VSi ₂	MoSi ₂ -10VSi ₂
WSi ₂ -20%VSi ₂	MoSi ₂ -20VSi ₂
WSi ₂ -30%VSi ₂	MoSi ₂ -30VSi ₂
WSi ₂ -10%TiSi ₂	MoSi ₂ -10TiSi ₂
WSi ₂ -20%TiSi ₂	MoSi ₂ -20TiSi ₂
WSi ₂ -30%TiSi ₂	MoSi ₂ -30TiSi ₂
WSi ₂ -10%CrSi ₂	MoSi ₂ -10CrSi ₂
WSi ₂ -20%CrSi ₂	MoSi ₂ -20CrSi ₂
WSi ₂ -30%CrSi ₂	MoSi ₂ -30CrSi ₂

The procedure for evaluating these systems was as follows:

- a) The silicide powders (-325 mesh), blended in the desired proportion, were milled for 24 hours in a chrome steel mill, leached with dilute acid, washed with distilled water and dried.
- b) The milled powders were pelletized at 30 tsi and pre-alloyed at 2730°F for 72 hours under argon. In the case of the WSi₂-TiSi₂ system the pellets shattered during the

prealloying cycle. According to G. V. Samsonov, et al (2) new phases having a hexagonal structure are formed with this type of alloy. Therefore, the shattering of the pellets probably resulted from the high stress development that accompanied the phase transformations. The shattered pellets were reworked (crushed, ballmilled, pelletized and prealloyed for 72 hours at 2730°F in argon) and oxidation tested at 1500°F for "pest" evaluation.

- c) Three pellets of each silicide combination were fractured and oxidation tested at 1500°F to determine the extent of "pest" formation. The results are summarized in Table 4.

Of the silicide systems evaluated, none of the MoSi₂-base binary systems showed pest formation after 600 hours of testing, whereas in the WSi₂-base system, only the WSi₂-30CrSi₂ did not form the "pest" after 600 hours of testing. All the other combinations containing WSi₂ exhibited some degree of pest formation after short exposure times (16 hours) at 1500°F. The pellets containing the higher additive concentration showed the least amount of pest formation while the pellets containing 10% and 20% TiSi₂ additions exhibited catastrophic "pest" attack. The oxidation test results for the WSi₂-30VSi₂ pellets were in agreement with the results of the X-ray analysis of this system which indicated the presence of free WSi₂ after prealloying.

On the basis of these results only the MoSi₂-base coating system was selected for further optimization and the WSi₂-base coating systems were eliminated from the program. As the program progressed, however, it became apparent that optimization of the process parameters, although improving the oxidation performance of the various silicide coating systems to some degree, did not resolve the poor coating reliability problem associated with the binary, single-layer silicide coating systems.

In order to realize this program objective the following six silicide coating systems were also selected for evaluation:

- a) MoSi₂-CrSi₂/VSi₂ (barrier layer)
- b) MoSi₂-TiSi₂/VSi₂ (barrier layer)
- c) Siliconized Mo-15.4Ti
- d) MoSi₂-15CrSi₂-15VSi₂
- e) CrSi₂-20TiSi₂
- f) MoSi₂-WSi₂-TiSi₂-VSi₂

TABLE 4

RESULTS OF OXIDATION TESTS OF VARIOUS
MIXED SILICIDE PELLETS AT 1500°F

<u>Silicide System</u>	<u>Exposure Time at 1500°F (hours)</u>	<u>Results</u>
WSi ₂ -10VSi ₂	2	Catastrophic pest formation
WSi ₂ -20VSi ₂	2	Catastrophic pest formation
WSi ₂ -30VSi ₂	2	Slight pest formation
WSi ₂ -10VSi ₂	16	Catastrophic pest formation
WSi ₂ -20VSi ₂	16	Catastrophic pest formation
WSi ₂ -30VSi ₂	16	Slight pest formation
WSi ₂ -10CrSi ₂	71 - 141 (over weekend)	Slight pest formation
WSi ₂ -20CrSi ₂	71 - 141 (over weekend)	Slight pest formation
WSi ₂ -30CrSi ₂	600	No indication of pest
MoSi ₂ -10VSi ₂	600	No indication of pest
MoSi ₂ -20VSi ₂	600	No indication of pest
MoSi ₂ -30VSi ₂	600	No indication of pest
MoSi ₂ -10TiSi ₂	600	No indication of pest
MoSi ₂ -20TiSi ₂	600	No indication of pest
MoSi ₂ -30TiSi ₂	600	No indication of pest
MoSi ₂ -10CrSi ₂	600	No indication of pest
MoSi ₂ -20CrSi ₂	600	No indication of pest
MoSi ₂ -30CrSi ₂	600	No indication of pest

3.2.2. Coating Procedures

The coating material for each coating system was prepared according to procedures described in Section 3.1.2. The T-222 specimens (2 in x 1 in x 0.060 in) prior to coating, were tumbled for 24 hours in an alumina mill to radius the edges and corners, sandblasted with 60 grit alumina, washed, and vacuum annealed at 2550°F for 1 hour.

All coatings were electrophoretically applied from a typical dispersion containing 40 grams of solids dispersed in a medium of the following composition:

0.81 liters of 60 wt % isopropanol - 40 wt % nitromethane
1 gram zein activator
50 mgs $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$

Considerable difficulty was experienced in stabilizing electrophoretic dispersions containing the binary silicide powders so as to yield a 5.0 mil thick as-deposited coating. A 5-mil as-deposited thickness was required in order to obtain a nominal 2.5 mil-thick sintered coating. A large number of specimens had to be rejected after the sintering operation as a result of shrinkage cracks which developed in the coating. In order to circumvent this problem, it was decided to aim for a coating thickness which would not be troublesome to obtain during the electrophoretic deposition step of the process, and which would also be capable of being sintered free of defects.

Exploratory studies directed toward this objective were very encouraging. The study indicated that a 3.0-3.5 mil thick as-deposited coating could be readily applied electrophoretically and sintered free of shrinkage cracks to a thickness of 1.5-1.7 mils. This modification reduced considerably the number of specimens which had to be rejected after sintering.

The processing conditions for all specimens of each coating system which was investigated are tabulated in Appendix A. It will be noted that in some instances the processing conditions were modified from the "standard" procedures in order to expedite the coating program. For example, in sintering the MoSi_2 -base coating systems, containing 30% additions of VSi_2 or TiSi_2 , the coatings, in a majority of cases, did not adhere to the T-222 substrate. It was observed that the coating, after cooling to room temperature, broke away or spalled from the substrate as shown in Figure 3. This phenomenon indicated the formation of a weak coating structure that could not contain the thermally induced stresses of the coating-substrate system. In order to strengthen the coating structure it was found necessary in this case to increase the sintering temperature from 2910°F to 3090°F. The

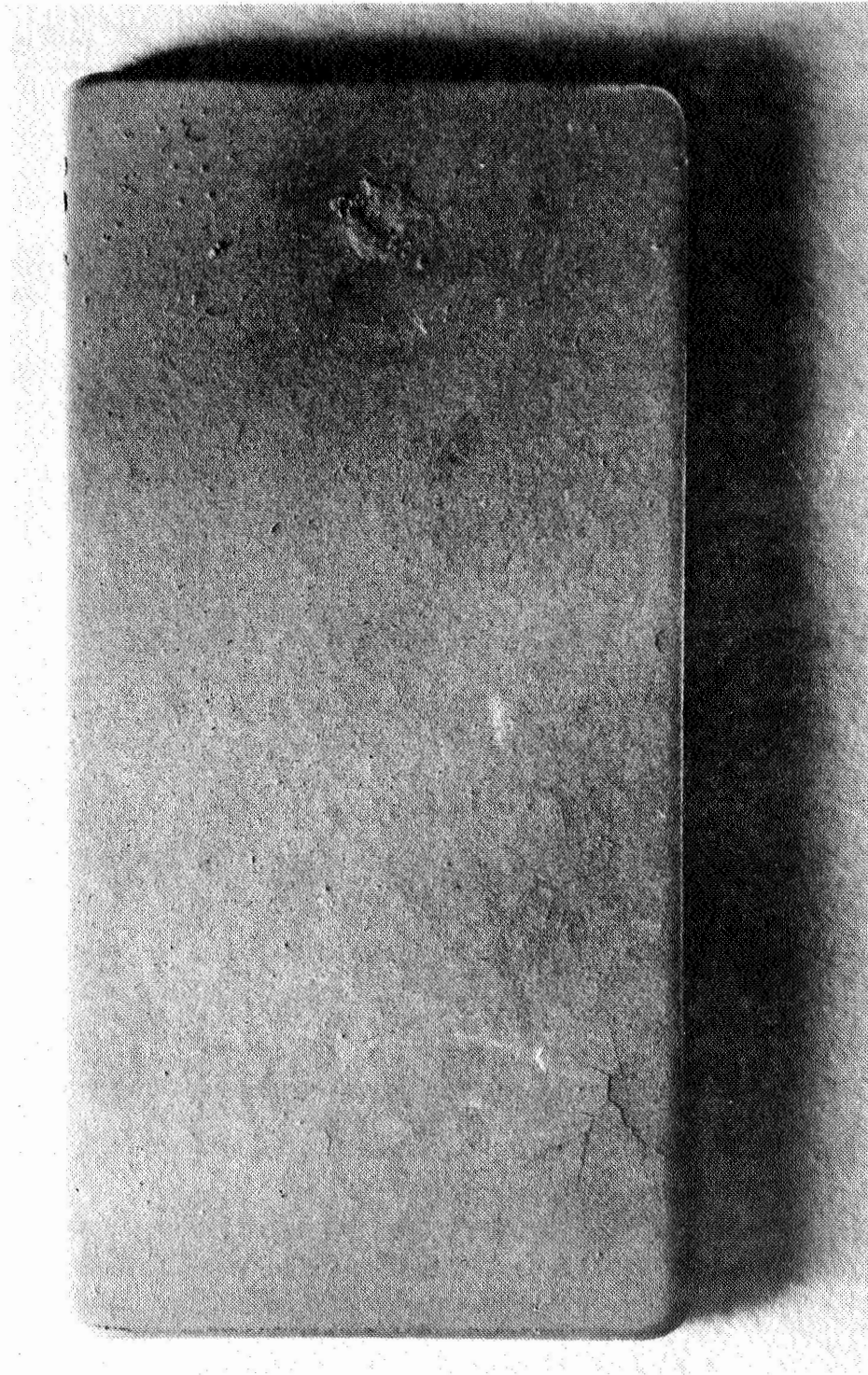


FIGURE 3 Magnification 3X

TYPICAL COATING FAILURE OF MoSi_2 -30 VSi_2 ON T-222
AFTER SINTERING AT 2910° F FOR 2 HOURS UNDER ARGON

structural differences between the 2910°F and 3090°F sintered MoSi₂-30VSi₂ coatings are shown in the photomicrographs of Figure 4. The higher sintering temperature apparently served to partially eliminate the void between the coating and the diffusion zone.

3.2.3 Optimization of Process Parameters

The coating process parameters investigated during this program included:

- a) Coating Composition
- b) Siliconization Times
- c) Preoxidation Time and Temperature
- d) Double Layer Coating Application.

Coating Composition

The coating compositions evaluated in this study consisted of:

- a) MoSi₂ coatings containing 10%, 20%, and 30% additions of CrSi₂
- b) MoSi₂ coatings containing 10%, 20%, and 30% additions of TiSi₂
- c) MoSi₂ coatings containing 10%, 20%, and 30% additions of VSi₂
- d) Siliconized Mo-15.4Ti
- e) MoSi₂-15CrSi₂-15VSi₂
- f) MoSi₂-30CrSi₂/VSi₂ (barrier layer)
- g) MoSi₂-40CrSi₂/VSi₂ (barrier layer)
- h) MoSi₂-20TiSi₂/VSi₂ (barrier layer)
- i) 35MoSi₂-35WSi₂-15TiSi₂-15VSi₂
- j) 33.6MoSi₂-27.6WSi₂-19.7TiSi₂-19.1VSi₂

All coating compositions with the exception of metallic coating d) were prepared from silicide powders that were prealloyed under conditions described in Section 3.2.1. The Mo-15.4Ti coatings were prepared from mechanically blended powders.

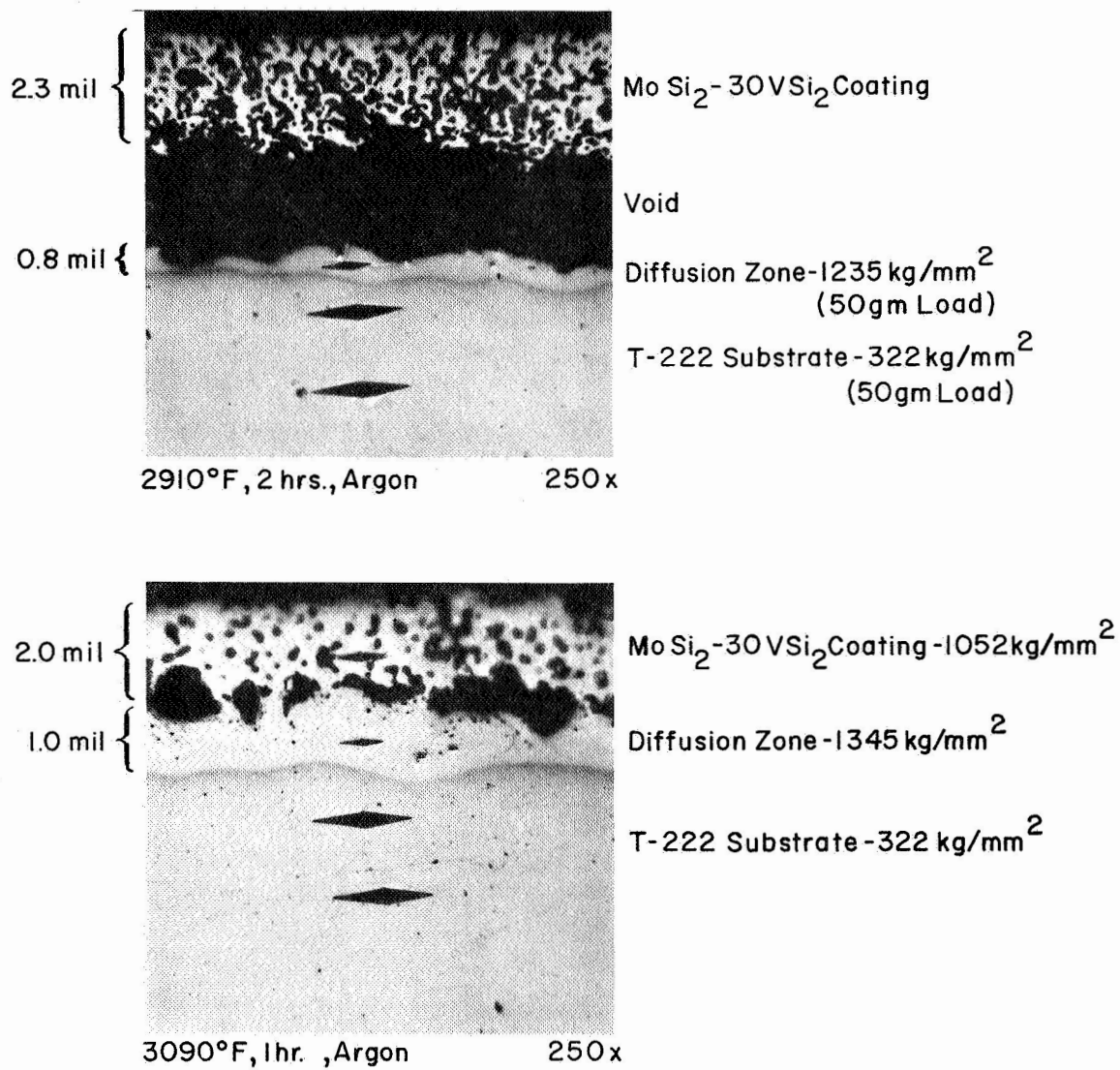


FIGURE 4

EFFECT OF SINTERING TEMPERATURE ON THE COATING
STRUCTURE OF THE MoSi₂-30VSi₂ COATING SYSTEM.

Siliconization Time

In this study the siliconization step of the coating process was optimized with respect to time in order to minimize the formation of $TaSi_2$ in the coating system. For this investigation, a total of 21 coated T-222 specimens were electrophoretically prepared from each of the three $MoSi_2$ -base binary coating system, and each specimen was densified at 30 tsi and sintered at $2910^{\circ}F$ ($3090^{\circ}F$ for the $MoSi_2$ -30 VSi_2 and $MoSi_2$ -30 $TiSi_2$ coatings) for 2 hours under argon. Seven specimens of each coating combination were exposed to a siliconization treatment at $2370^{\circ}F$ under reduced pressure (100mm) for time intervals of 0, 4, and 8 hours. Photomicrographs showing the coating structure and hardness values of each siliconized group are shown in Figures 5 to 13. As shown in Figures 5 - 13 no appreciable variations in the depth of diffusion can be detected in the T-222 substrates as a result of the various siliconization treatments. In subsequent oxidation tests, however, the unsilicided specimens performed poorly compared to those that were silicided. Since no appreciable difference was noted in the oxidation life of the 4 and 8 hour siliconized specimens, the 8 hour siliconization treatment was arbitrarily considered optimum and was employed in siliconizing all subsequent silicide coatings prepared in this program.

Preoxidation Time and Temperature

This study was concerned with establishing optimum preoxidation conditions that would extend the oxidation lives of the $MoSi_2$ -base coating systems at $1500^{\circ}F$ and $2400^{\circ}F$. In this investigation the 8 hour-siliconized $MoSi_2$ -20 $TiSi_2$ and $MoSi_2$ -10 VSi_2 coatings and the 8 hour and a 16 hour-siliconized $MoSi_2$ -30 $CrSi_2$ coating systems were selected on the basis of their past oxidation performance.

The coated specimens for this study were prepared as follows:

- a) The silicide coatings for the three coating combinations were electrophoretically deposited to a nominal 4.0 mil thickness which, upon sintering and siliciding, yielded a nominal 2.0 mil thick coating.
- b) All as-deposited coatings were densified at 10 tsi, preheated at $930^{\circ}F$ under argon to drive off organics and subsequently sintered at $2910^{\circ}F$ for 2 hours under argon.
- c) All sintered coatings were then silicided for 8 hours at $2370^{\circ}F$ under reduced pressure.

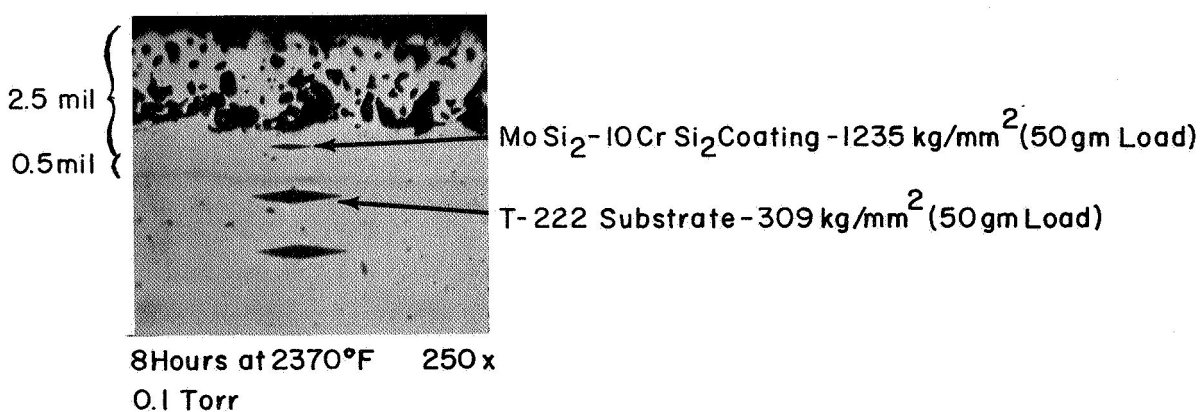
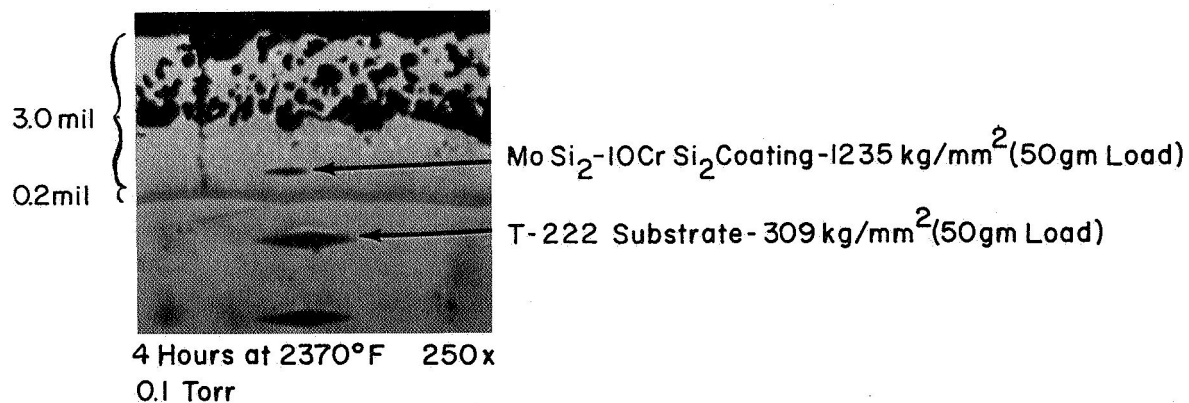
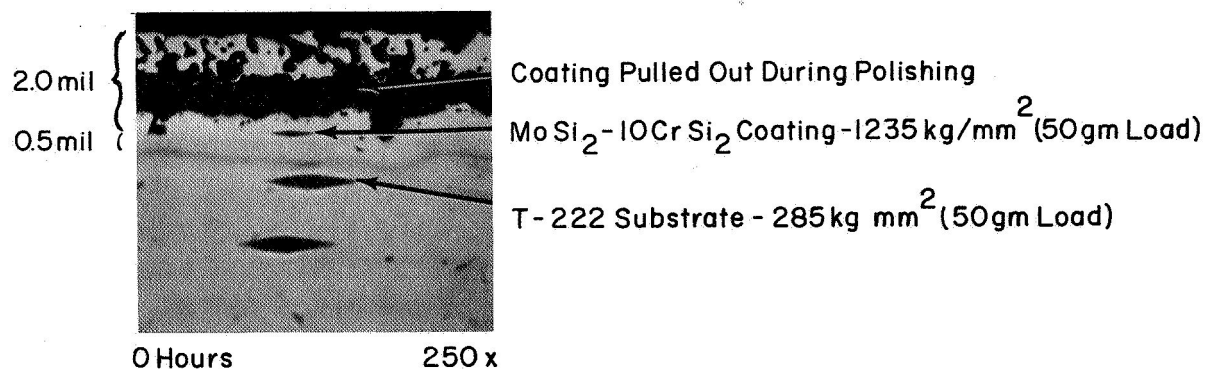


FIGURE 5

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-10CrSi₂ COATING ON T-222 SINTERED AT 2910° F

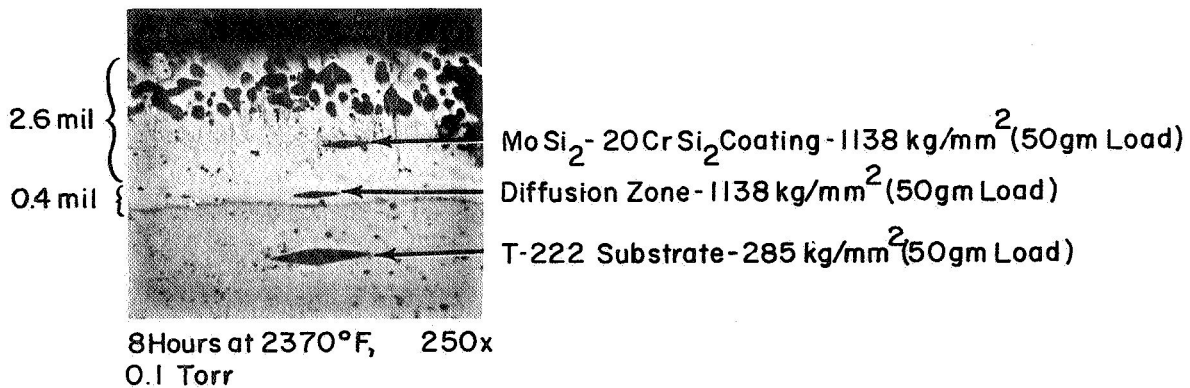
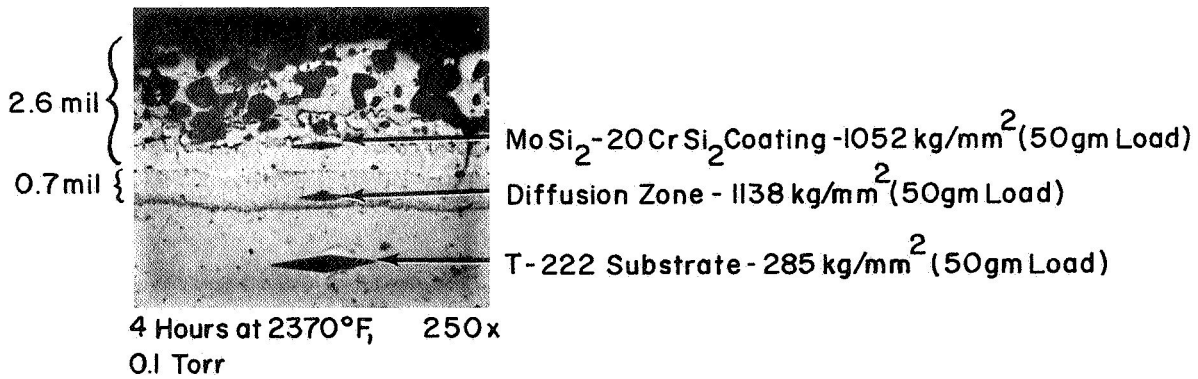
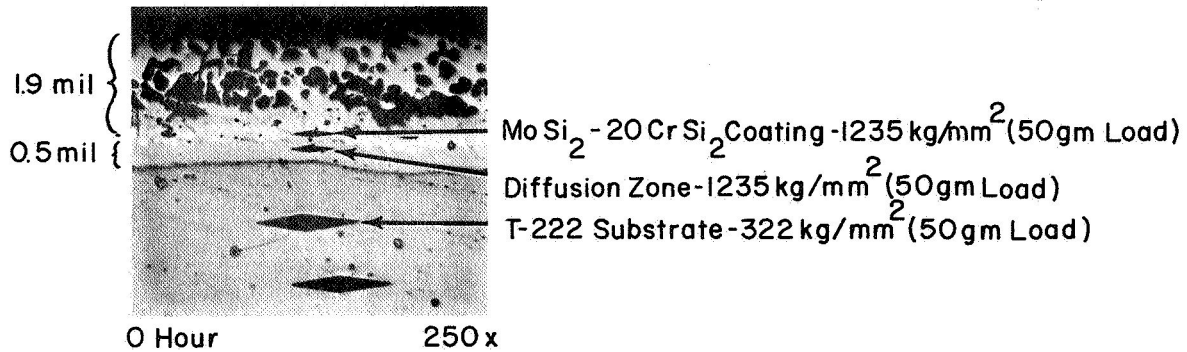


FIGURE 6

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-20CrSi₂ COATING ON T-222, SINTERED AT 2910°F

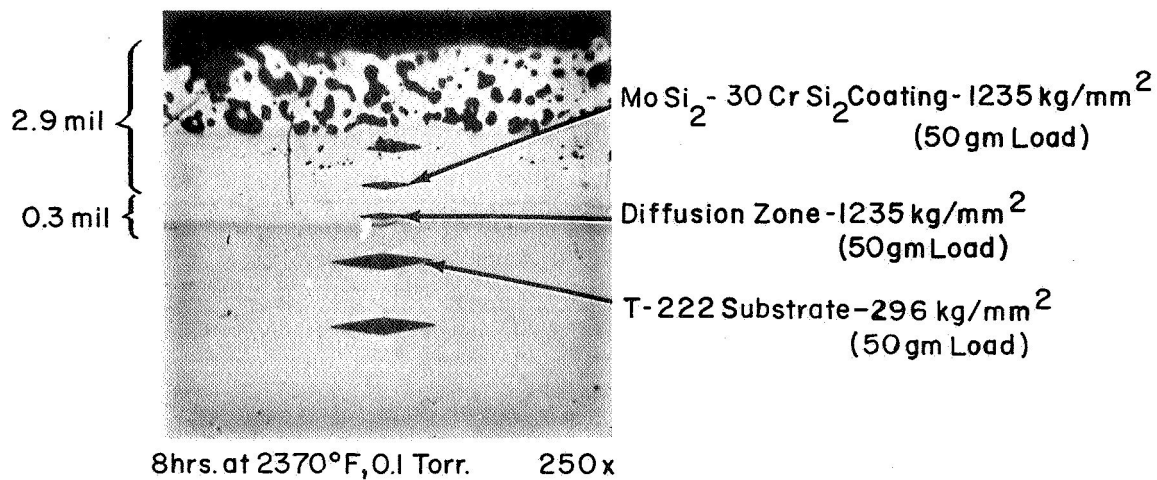
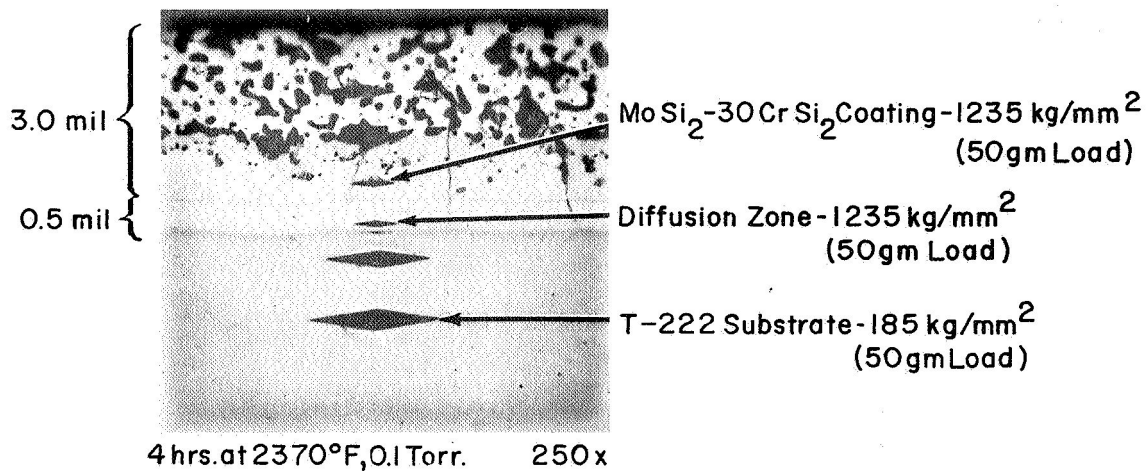
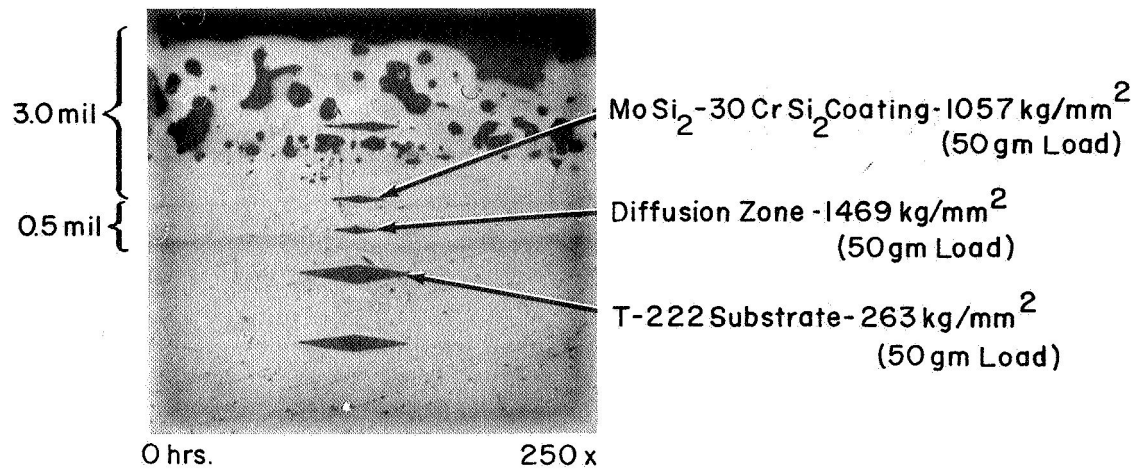


FIGURE 7

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-30CrSi₂ COATING ON T-222, SINTERED AT 2910°F

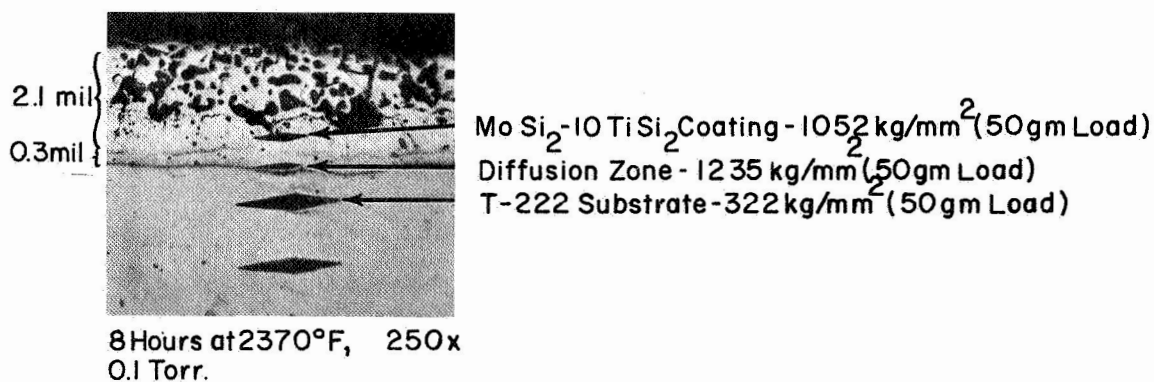
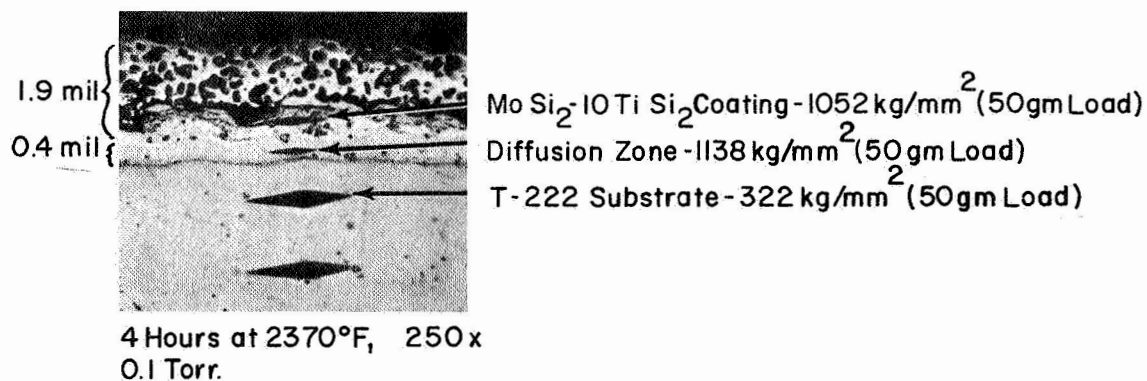
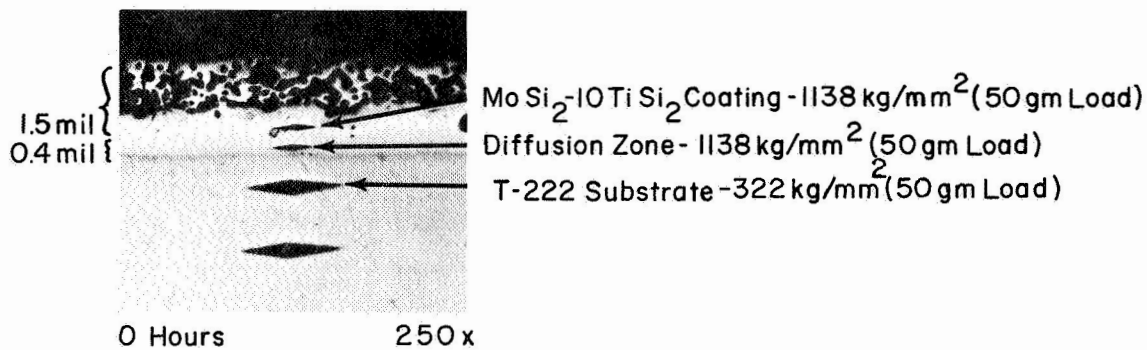


FIGURE 8

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-10TiSi₂ COATING ON T-222, SINTERED AT 2910°F

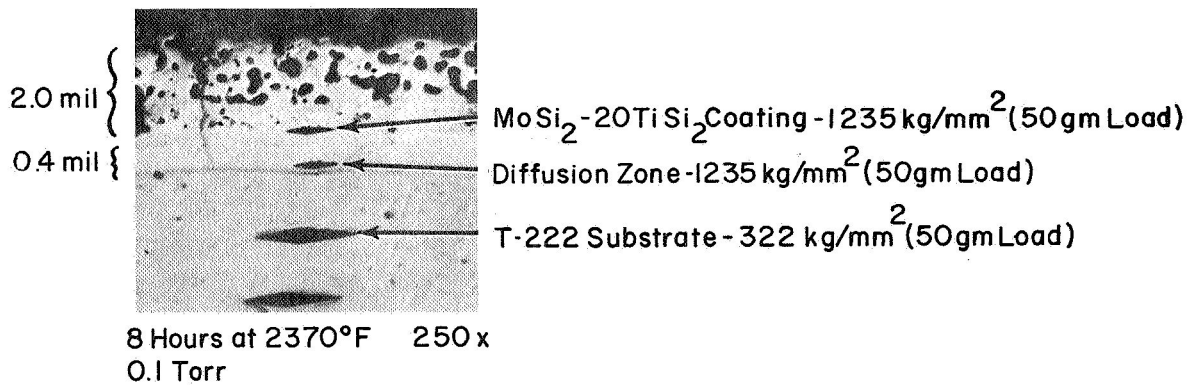
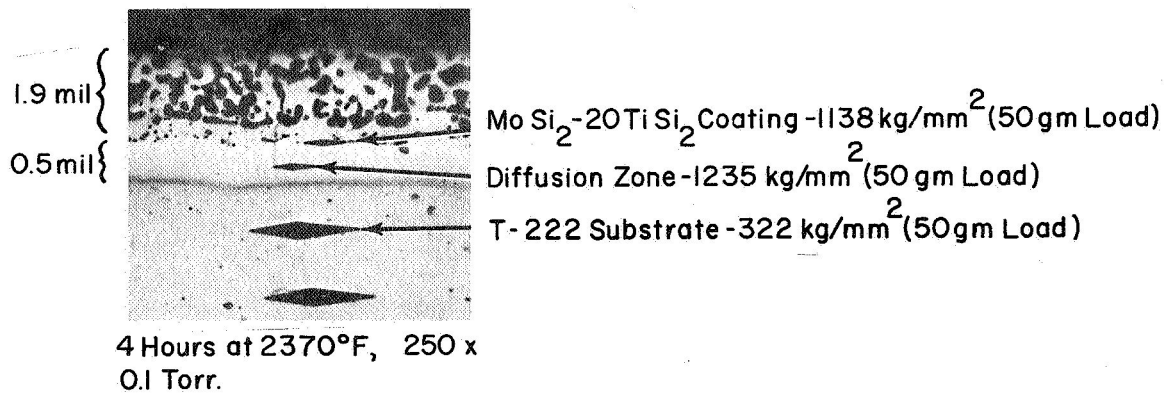
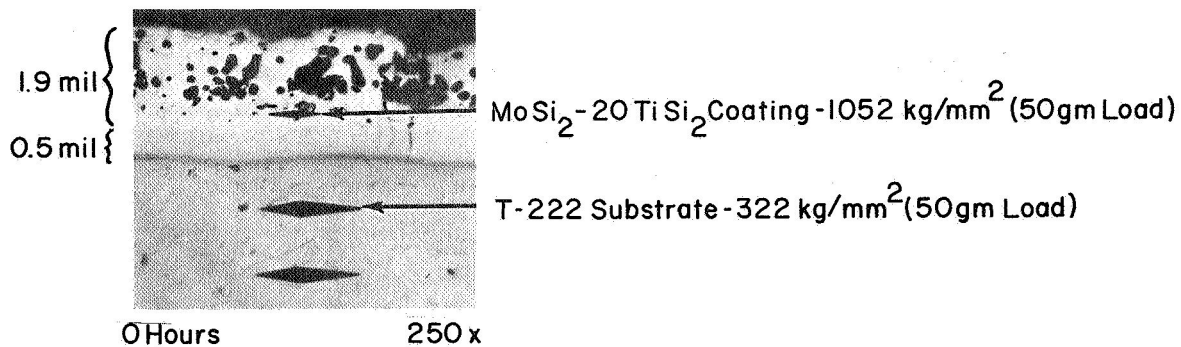


FIGURE 9

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-20TiSi₂ COATING ON T-222, SINTERED AT 2910°F

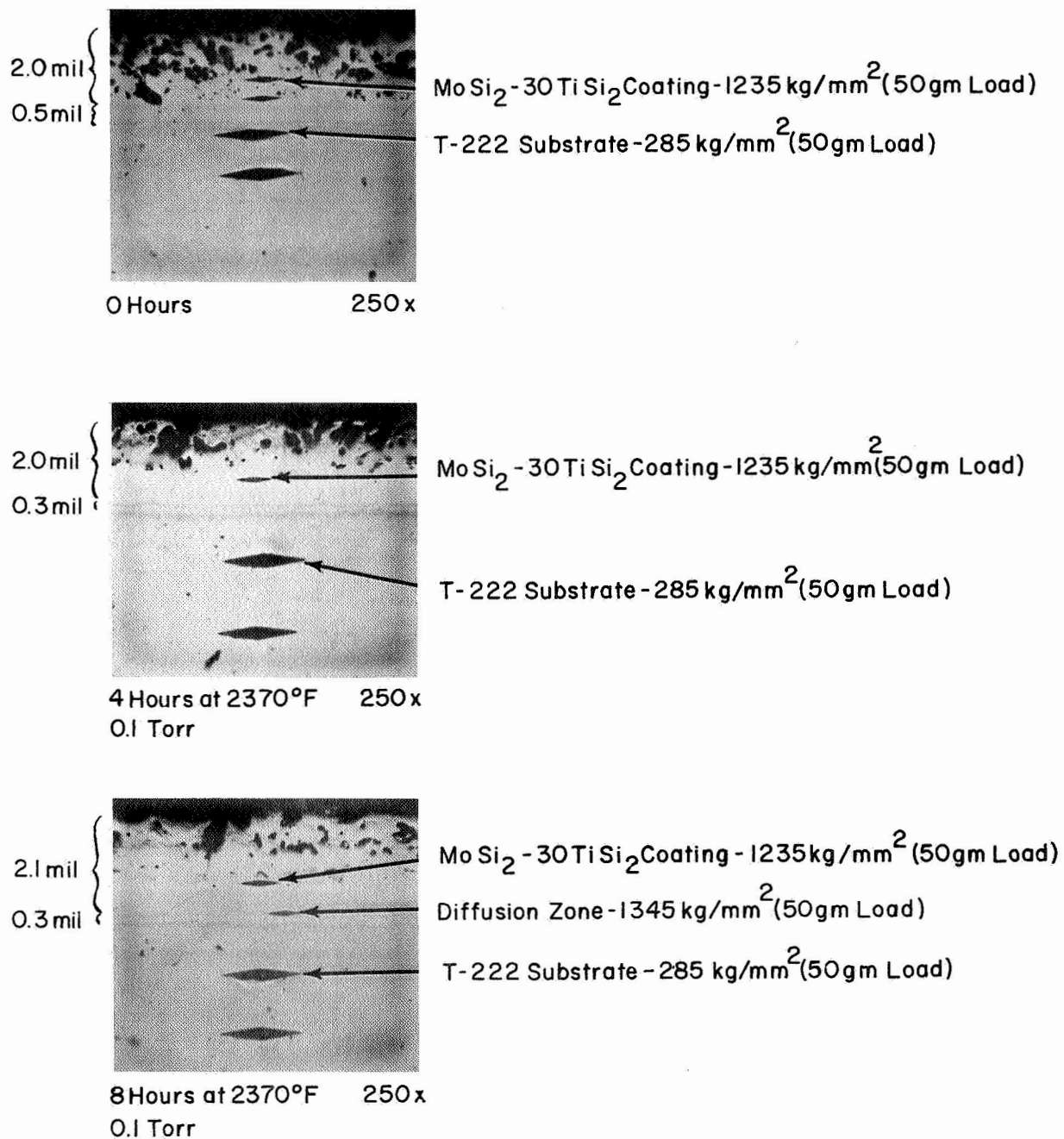


FIGURE 10

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-30TiSi₂ COATING ON T-222, SINTERED AT 2910°F

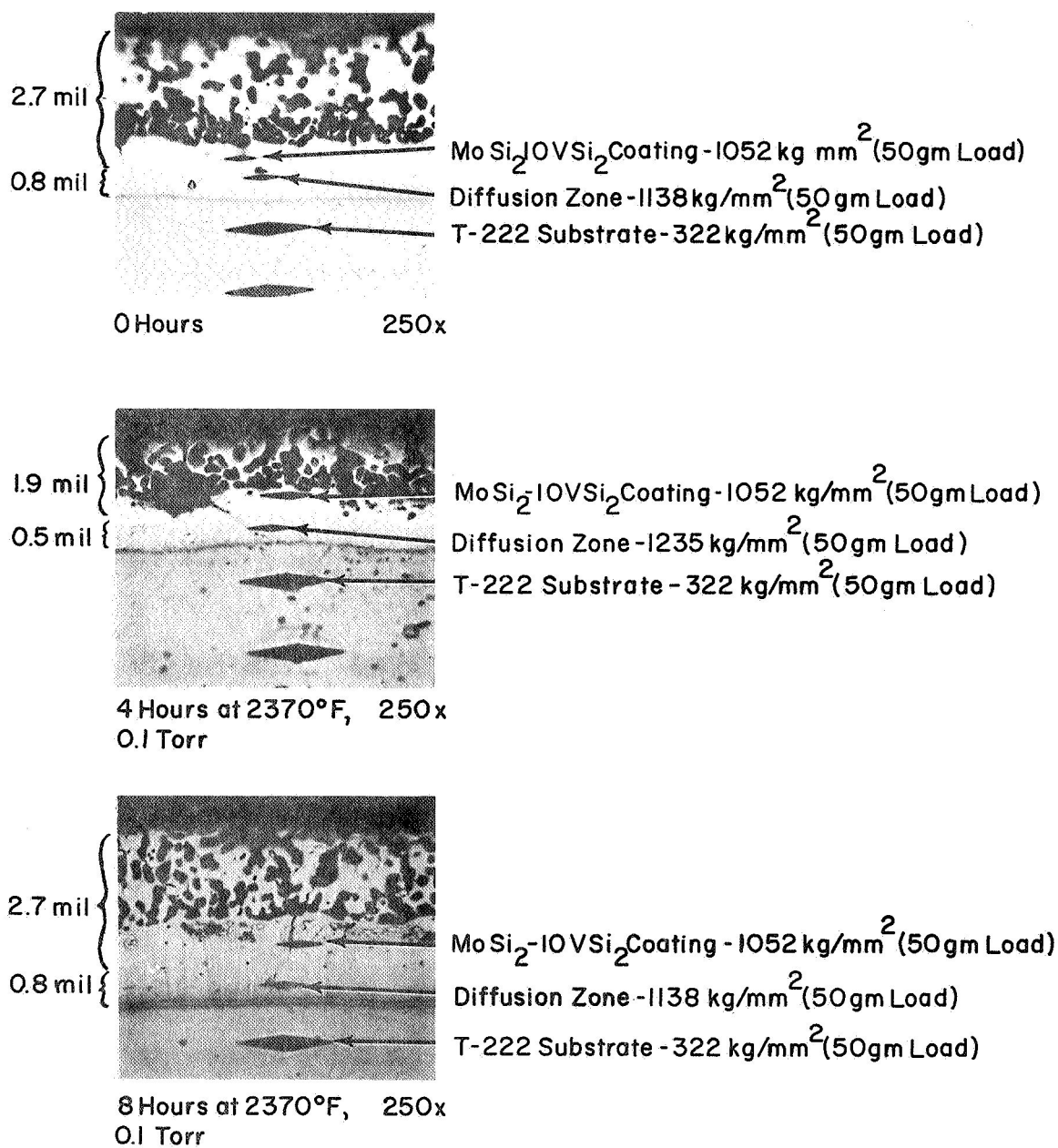


FIGURE 11

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-10VSi₂ COATING ON T-222, SINTERED AT 2910°F

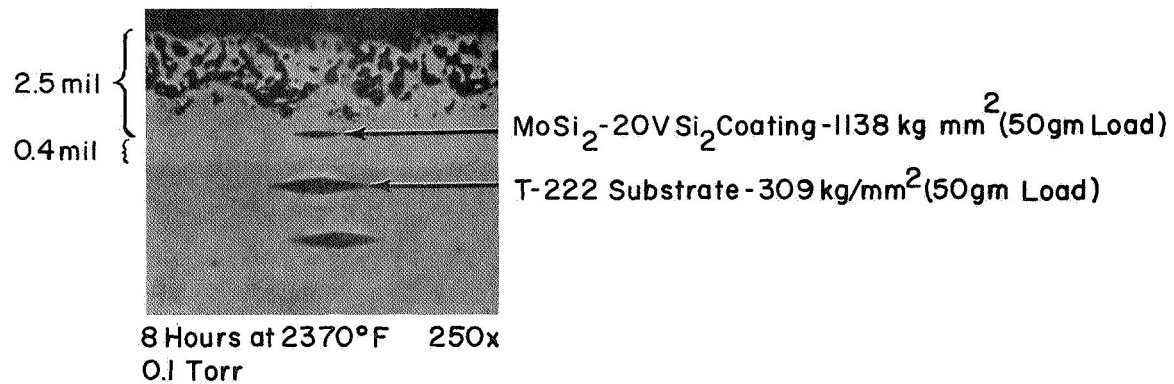
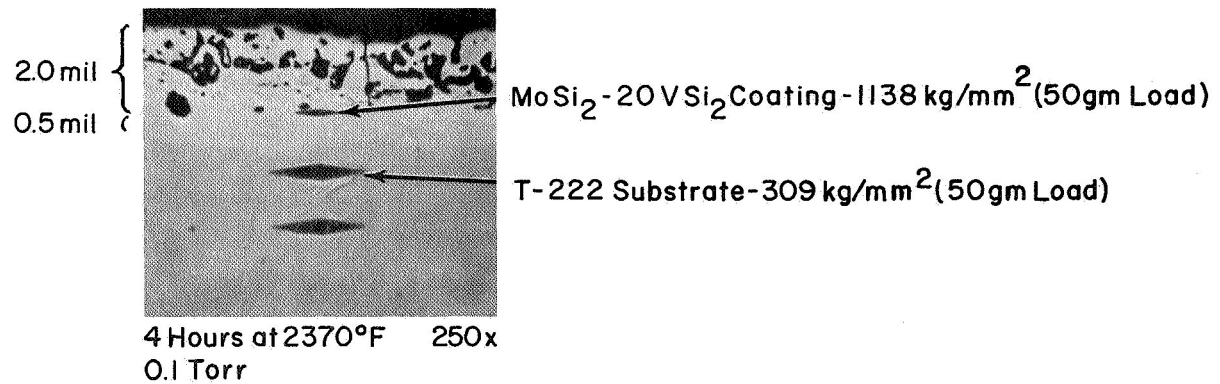
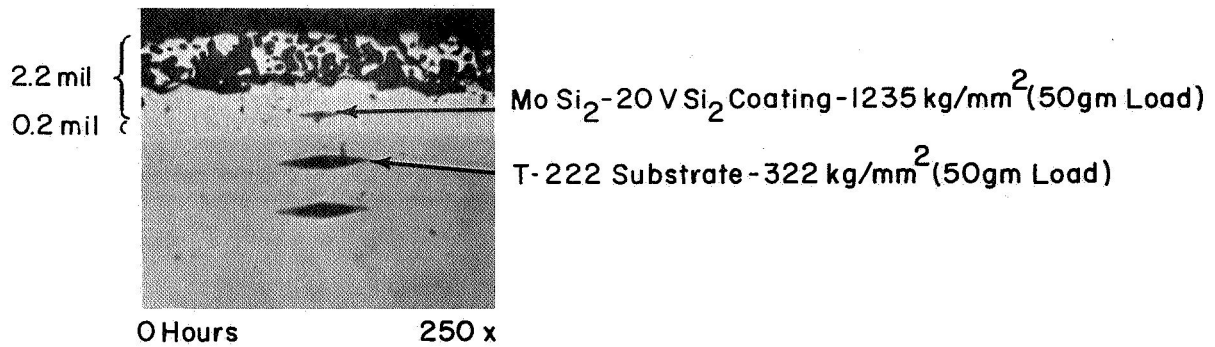
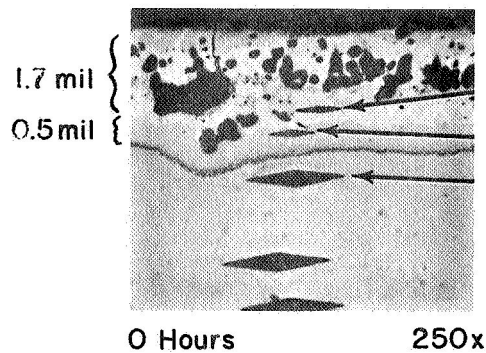
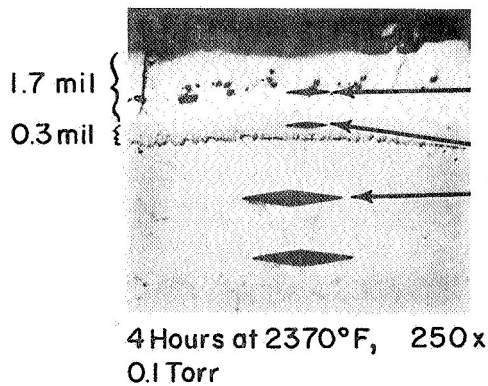


FIGURE 12

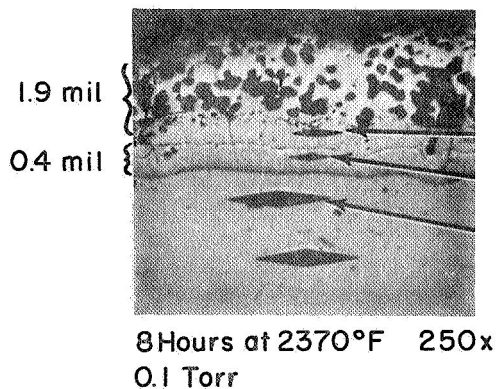
EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
MoSi₂-20VSi₂ COATING ON T-222, SINTERED AT 2910°F



MoSi₂-30VSi₂ Coating - 1052 kg/mm² (50 gm Load)
 Diffusion Zone - 1235 kg/mm² (50 gm Load)
 T-222 Substrate - 285 kg/mm² (50 gm Load)



MoSi₂-30VSi₂ Coating - 1052 kg/mm² (50 gm Load)
 Diffusion Zone - 1235 kg/mm² (50 gm Load)
 T-222 Substrate - 325 kg/mm² (50 gm Load)



MoSi₂-30VSi₂ Coating - 1075 kg/mm² (50 gm Load)
 Diffusion Zone - 1235 kg/mm² (50 gm Load)
 T-222 Substrate - 322 kg/mm² (50 gm Load)

FIGURE 13

EFFECT OF SILICONIZATION TIME ON STRUCTURE OF
 MoSi₂-30VS₂ COATING ON T-222, SINTERED AT 3090° F

- d) Seven specimens of each coating combination were finally preoxidized for 30 minutes at 2730°F, and 5, 15, and 30 minutes at 2910°F.
- e) Specimen weight gains were also recorded before and after siliciding and after each preoxidizing temperature and time interval.

Photographs depicting the coating structure and hardness values of each preoxidized system are shown in Figures 14 to 18.

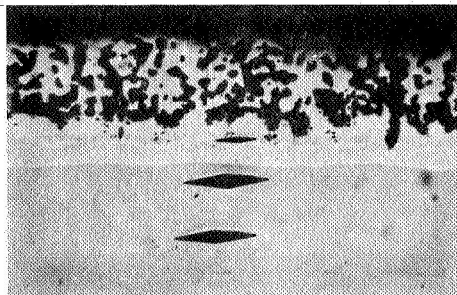
Double Coating Application

In oxidation tests relating to the siliconization study (Section 3.3.1.), premature coating failure occurred at edges, corners or a localized surface site presumably due to undetectable point defects present in the coating system prior to testing. To test this assumption, the silicide coatings were deposited in two separate layers in the hope that the second layer would cover any defects present in the initial silicide layer. In this study, three coating systems (MoSi_2 -30CrSi₂, MoSi_2 -20TiSi₂, and MoSi_2 -10VSi₂) were chosen for investigation on the basis of their past oxidation performance. Two coating layers for each system were applied electrophoretically to seven T-222 specimens to an overall nominal sintered thickness of 2.0 mils. The electrophoretically applied coatings were densified at 30 tsi and fired in argon at 2910°F for 1 hour. This treatment was repeated for each coating layer. The coated specimens were then siliconized at 2370°F for 8 hours under reduced pressure. Photomicrographs depicting the coating structure for these systems are shown in Figure 19.

3.3 Coating Evaluation Studies

3.3.1 Oxidation Tests of Selected Coating Systems Siliconized for Various Time Intervals

The MoSi_2 -base coating systems siliconized for various time intervals as described in Section 3.2.3 (Optimization of Process Parameters) were evaluated to determine their capability of providing the necessary oxidation protection to tantalum alloys at elevated temperatures. In this task, a total of 216 specimens of the various nine (9) coating combinations were satisfactorily prepared according to procedures described in Section 3.3.3 and screened in triplicate by cyclic testing at 1500°F and 2400°F. Testing was performed with the same type of quartz setter material and specimen arrangement that was used in Contract NAS 3-7613. The test arrangement is shown schematically in Figures 20 and 21.



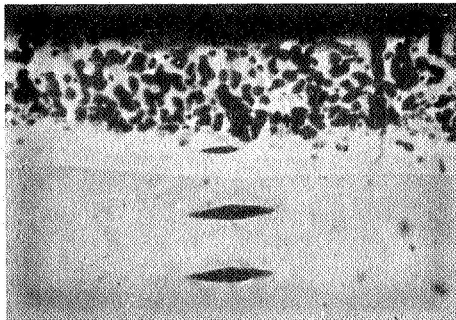
Mo Si₂-10 V Si₂ Coating

1235 kg/mm² (50 gm Load)

T-222 Substrate - 322 kg/mm² (50 gm Load)

Preoxid. 5 mins.
at 2910°F

250x



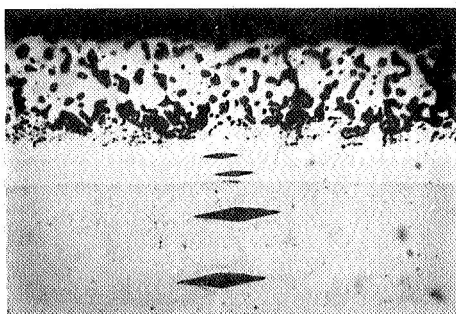
Mo Si₂-10 V Si₂ Coating

1235 kg/mm² (50 gm Load)

T-222 Substrate - 322 kg/mm² (50 gm Load)

Preoxid. 15 mins.
at 2910°F

250x



Mo Si₂-10 V Si₂ Coating

1235 kg/mm² (50 gm Load)

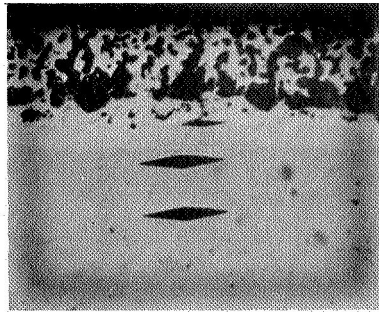
T-222 Substrate - 322 kg/mm² (50 gm Load)

Preoxid. 30 mins.
at 2910°F

250x

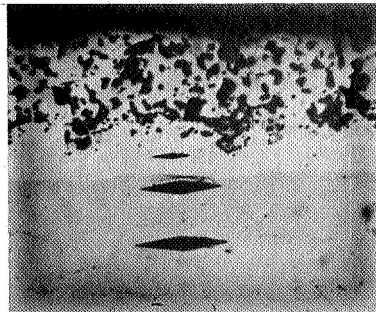
FIGURE 14

MoSi₂-10VSi₂ COATED T-222 SPECIMENS PREOXIDIZED
AT 2910°F FOR VARIOUS TIME INTERVALS



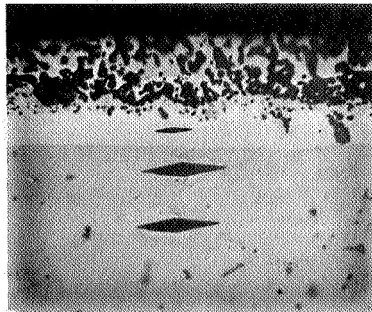
Preoxid. 5 mins. 250 x
at 2910°F

Mo Si₂-20 Ti Si₂ Coating
1235 kg/mm² (50 gm Load)
T-222 Substrate - 322 kg/mm² (50 gm Load)



Preoxid. 15 mins. 250x
at 2910°F

Mo Si₂-20 Ti Si₂ Coating
1235 kg/mm² (50 gm Load)
T-222 Substrate - 351 kg/mm² (50 gm Load)

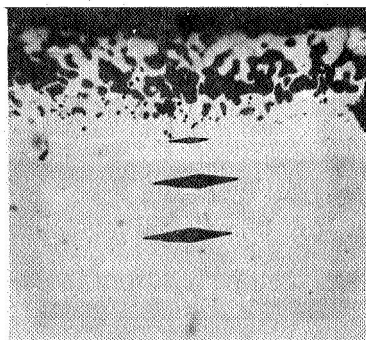


Preoxid. 30 mins. 250x
at 2910°F

Mo Si₂-20 Ti Si₂ Coating
1235 kg/mm² (50 gm Load)
T-222 Substrate - 322 kg/mm² (50 gm Load)

FIGURE 15

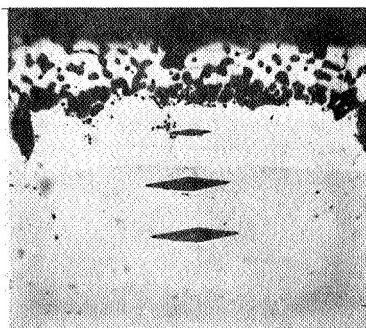
MoSi₂-20TiSi₂ COATED T-222 SPECIMENS PREOXIDIZED
AT 2910°F FOR VARIOUS TIME INTERVALS



Preoxid. 5 mins.
at 2910°F 250 x

Mo Si₂-30Cr Si₂ Coating
1235 kg/mm² (50gm Load)

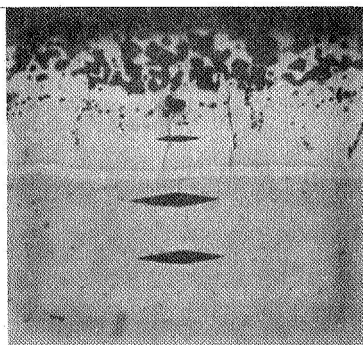
T-222 Substrate-309 kg/mm² (50gm Load)



Preoxid. 15 mins.
at 2910°F 250 x

Mo Si₂-30Cr Si₂ Coating
1235 kg/mm² (50gm Load)

T-222 Substrate-322 kg/mm² (50gm Load)



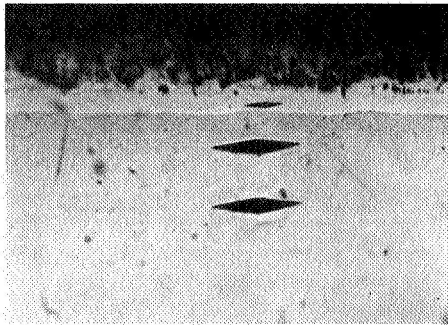
Preoxid. 30 mins.
at 2910°F 250 x

Mo Si₂-30Cr Si₂ Coating
1235 kg/mm² (50gm Load)

T-222 Substrate- 322 kg/mm² (50gm Load)

FIGURE 16

MoSi₂-30CrSi₂ COATED T- 222 SPECIMENS PREOXIDIZED
AT 2910°F FOR VARIOUS TIME INTERVALS

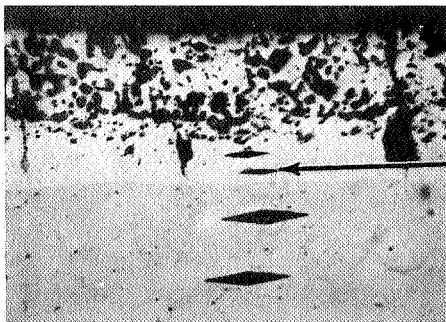


250x

MoSi₂-10VSi₂ Coating

1235 kg/mm² (50 gm Load)

T-222 Substrate-322 kg/mm² (50gm Load)

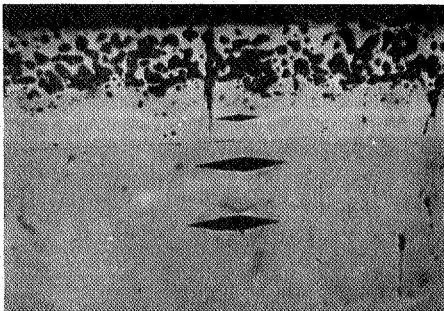


250x

MoSi₂-20TiSi₂ Coating-1138 kg/mm² (50gm Load)

1345 kg/mm² (50gm Load)

T-222 Substrate-322 kg/mm² (50gm Load)



250x

MoSi₂-30CrSi₂ Coating

1235 kg/mm² (50 gm Load)

T-222 Substrate- 309 kg/mm² (50gm Load)

FIGURE 17

MoSi₂-10VSi₂, MoSi₂-20TiSi₂ AND MoSi₂-30CrSi₂ COATED T-222
SPECIMENS PREOXIDIZED AT 2730°F FOR 30 MINUTES

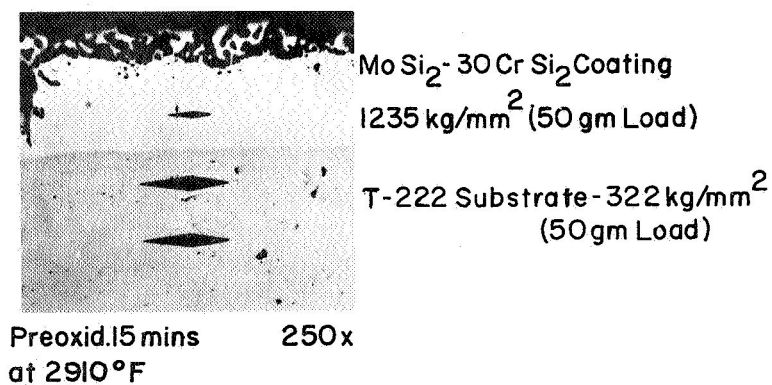
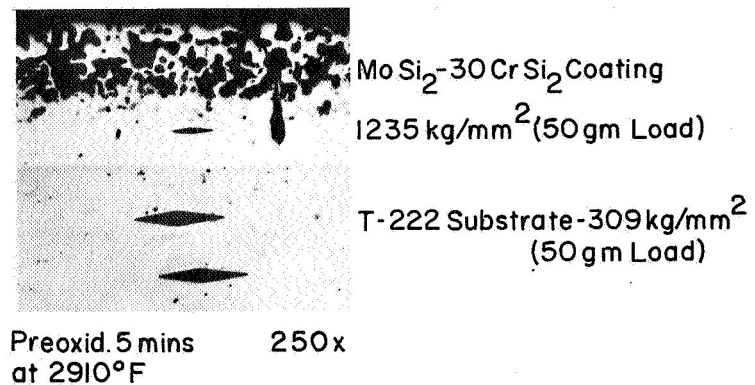


FIGURE 18

MoSi₂-30CrSi₂ COATED T-222 SPECIMENS, SILICONIZED 16 HOURS,
AND PEOXIDIZED AT 2910° FOR VARIOUS TIME INTERVALS

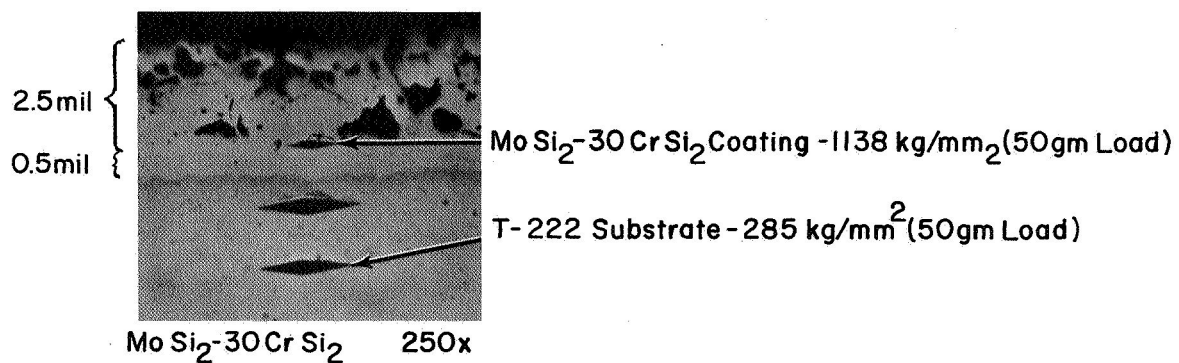
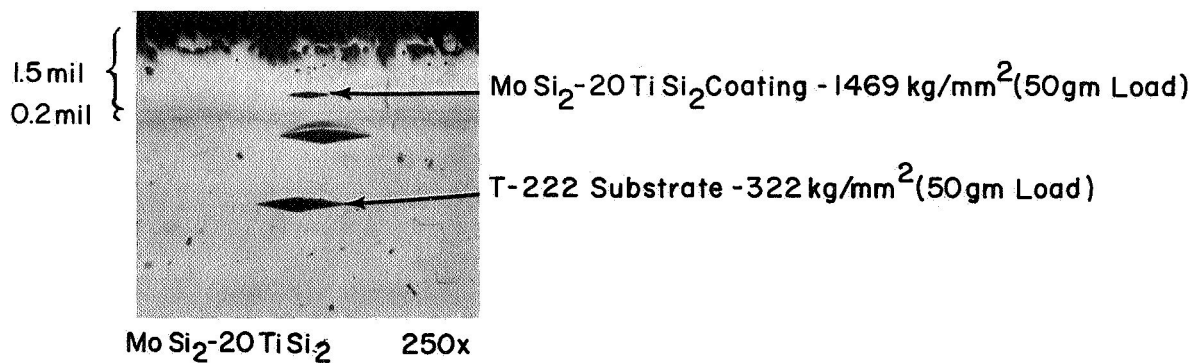
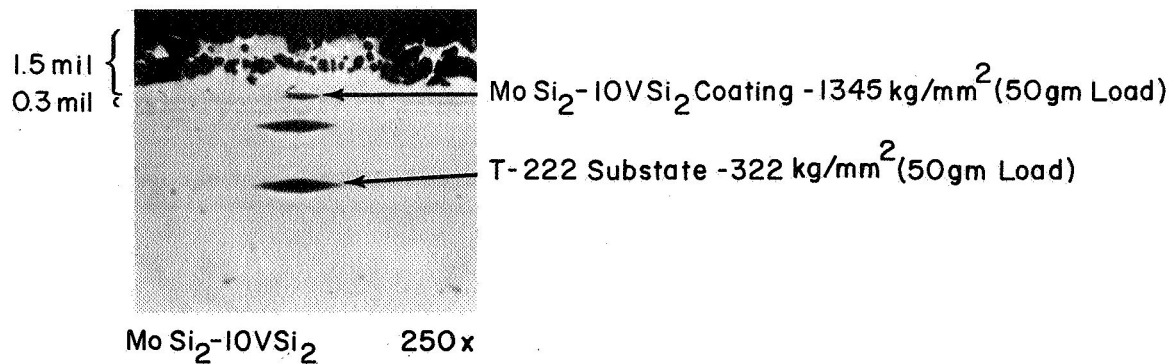


FIGURE 19

STRUCTURE OF THE MoSi₂-10VSi₂, MoSi₂-20TiSi₂
AND MoSi₂-30CrSi₂ COATING SYSTEM APPLIED
AS A DOUBLE COATING ON T-222

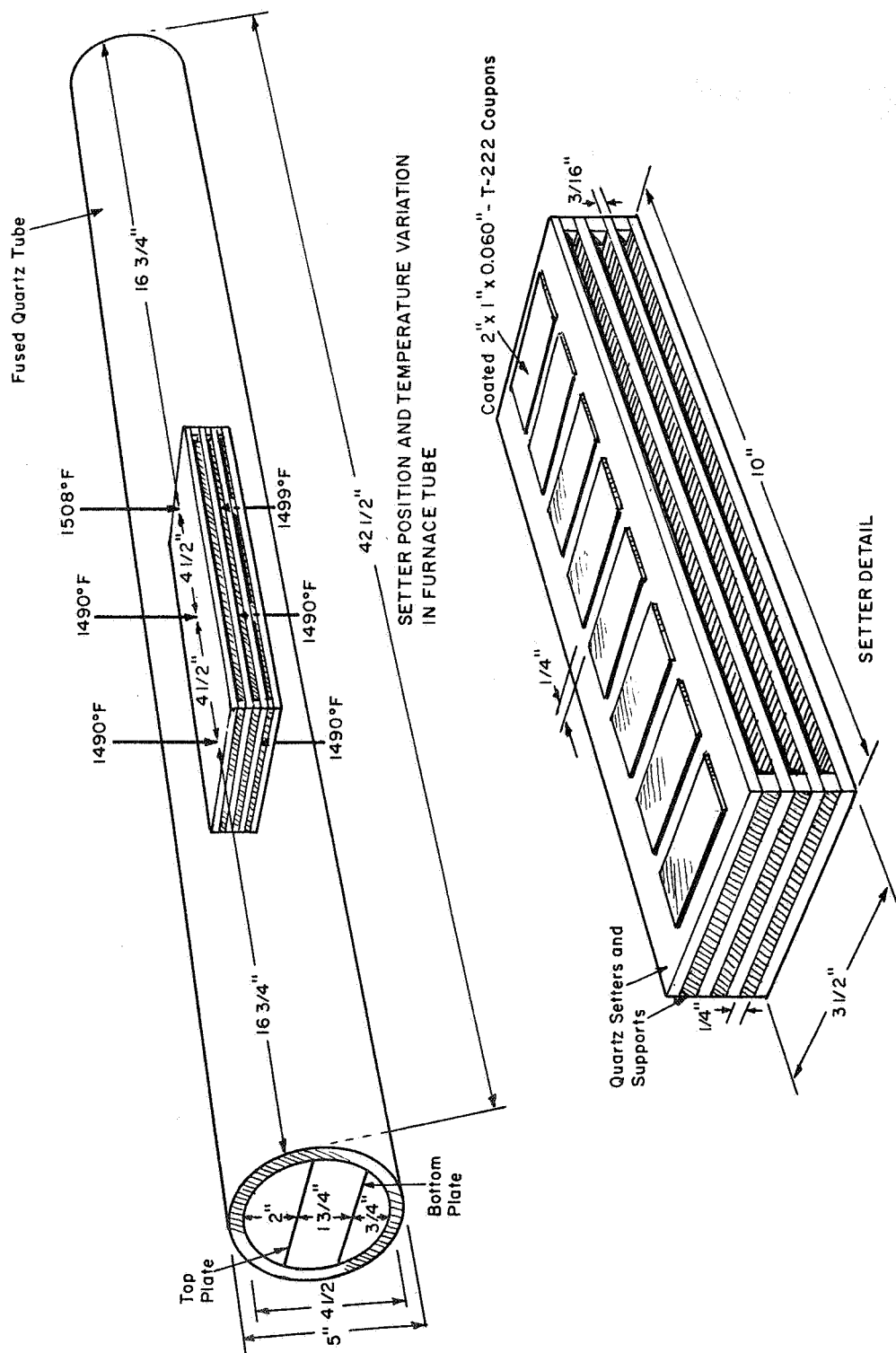


FIGURE 20
SPECIMEN ARRANGEMENT - 1500 °F OXIDATION TEST

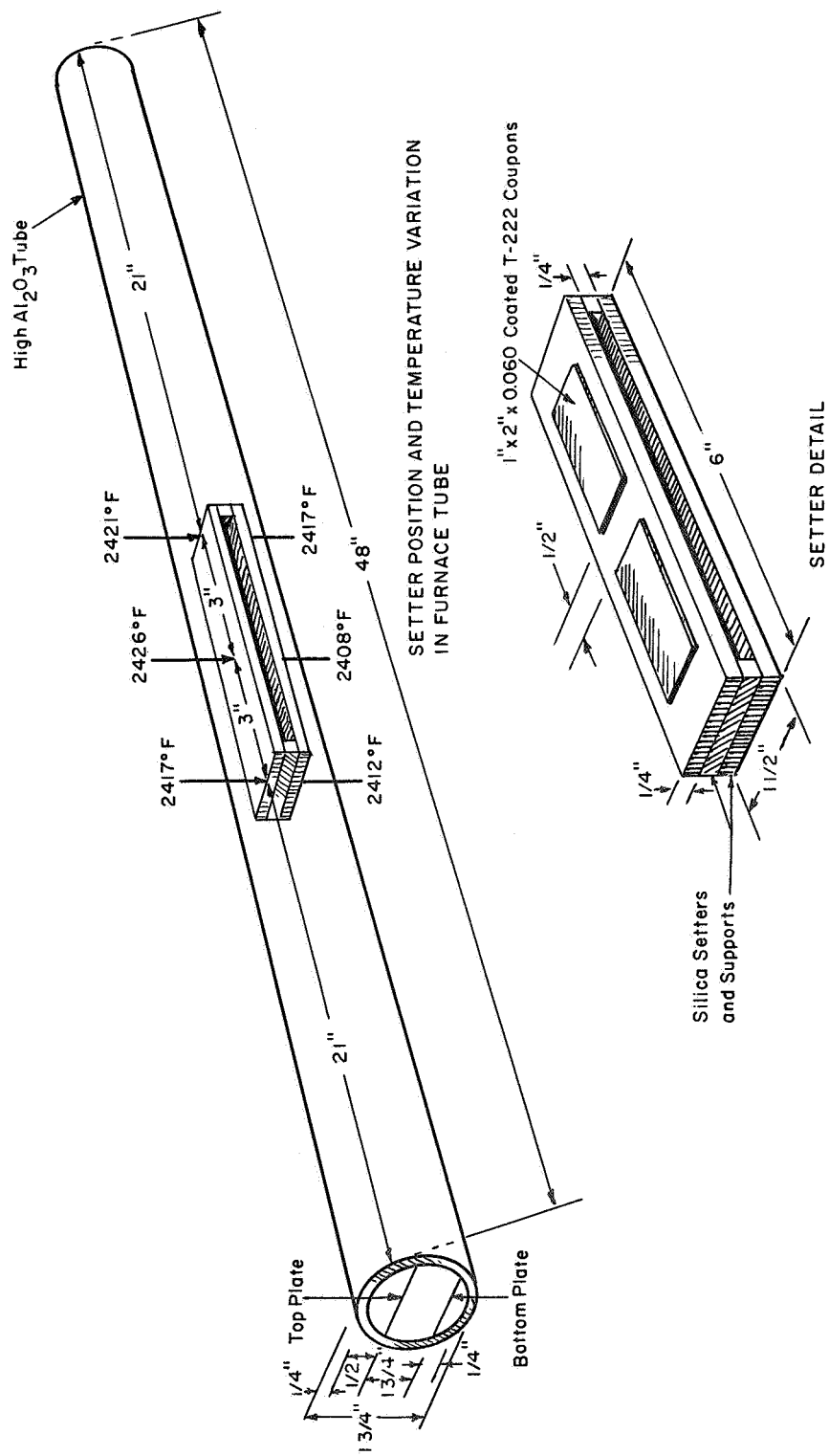


FIGURE 21
SPECIMEN ARRANGEMENT - 2400°F OXIDATION TEST

Although not indicated in the schematic drawings, the specimens in this program were raised from the setter plate by means of two 1/4 in x 1/4 in silica platelets placed at each end of the specimen, thus assuring approximately the same exposure conditions for both sides of the specimen during testing. The test cycles were every 2 hours during the work day with continuous testing overnight and during weekends. Deviations from the planned test cycles occurred on occasions during periodic maintenance of the furnaces.

The coating processing data and oxidation test results are tabulated for all specimens in Appendix A (pages A-1 to A-27) and are summarized in Figures 22 and 23. Photographs of the tested specimens are shown in Figures 24 through 32.

Of the coating systems investigated, the $\text{MoSi}_2\text{-30CrSi}_2$ exhibited the best oxidation performance at 1500°F and 2400°F irrespective of the siliconization treatment employed. All specimens but one (8 out of 9 tested) survived the 400 hour cyclic test at 1500°F . A single specimen failed at a localized corner site after 364 hours of testing.

At 2400°F one specimen from each siliconized group of three $\text{MoSi}_2\text{-30CrSi}_2$ specimens survived 116 - 234 hours while the remaining specimens failed after 20 - 50 hours of cyclic testing.

Poorer oxidation performance was noted for the $\text{MoSi}_2\text{-CrSi}_2$ coating system at lower concentration levels (10% and 20%) of CrSi_2 . The majority of specimens tested failed prematurely in less than 100 hours of testing. General failure occurred in most cases with the non-siliconized specimens while edge or corner failures were observed in the case of the siliconized specimens.

In the $\text{MoSi}_2\text{-VSi}_2$ coating system, the oxidation performance at 1500°F was considered very poor regardless of the VSi_2 concentration and siliconization time employed. All but one specimen failed within the first or second 2 hour cycle.

At 2400°F , the oxidation behavior of the $\text{MoSi}_2\text{-VSi}_2$ coating system was greatly improved by siliconization. The eight (8) hour-siliconized specimens performed the best, yielding oxidation lives of 406 hours for the three specimens tested. At VSi_2 concentration levels of 20% and 30%, oxidation lives in the range of 2 - 26 and 4 - 170 hours respectively were obtained on both the four (4) and eight (8) hour siliconized specimens. It should also be noted that the $\text{MoSi}_2\text{-30VSi}_2$ coatings were approximately 2.5 mils thick compared to the 2.0 mil thick $\text{MoSi}_2\text{-10VSi}_2$ and $\text{MoSi}_2\text{-20VSi}_2$ coatings indicating that application of thicker coatings had no effect in promoting improved oxidation

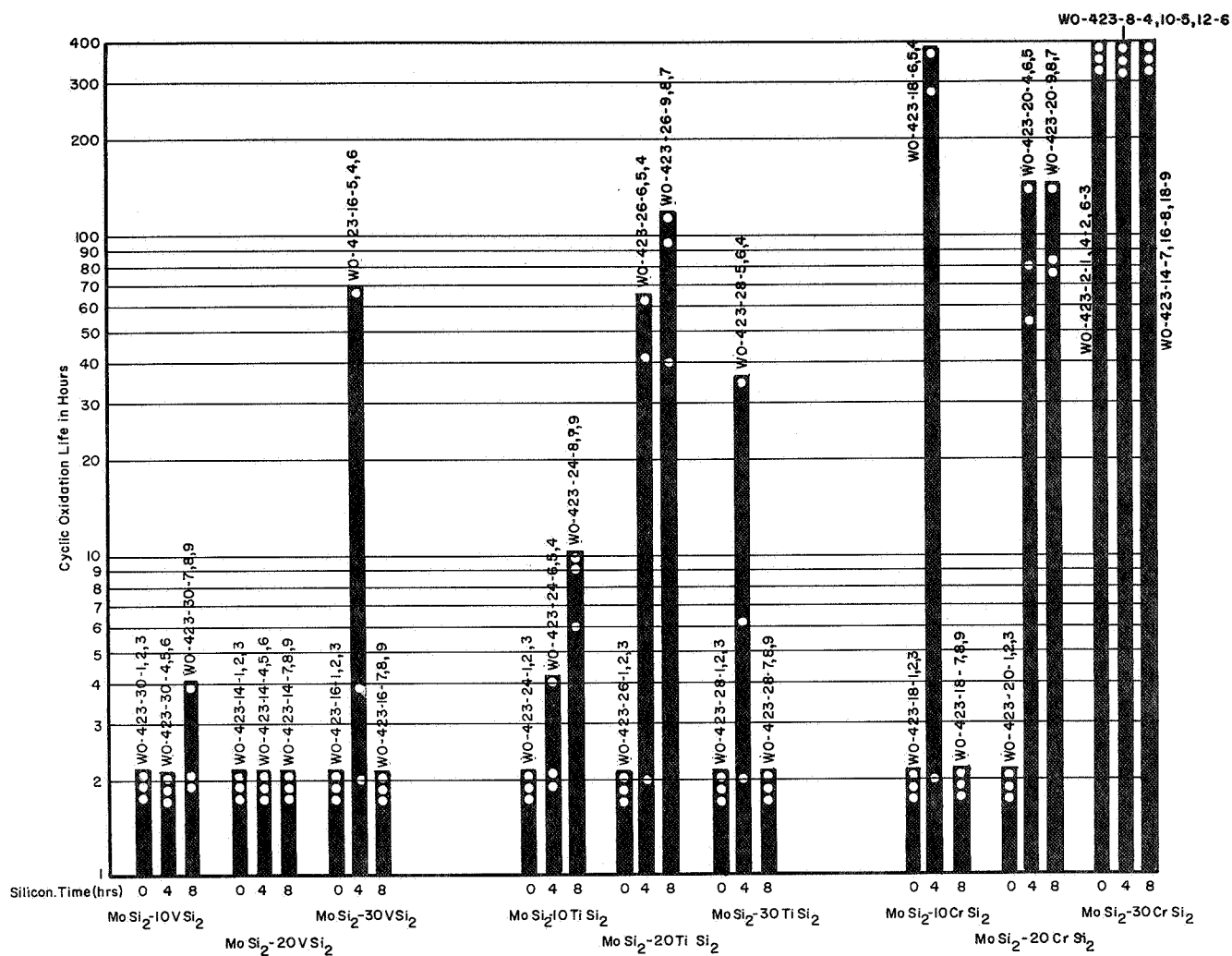


FIGURE 22

CYCLIC OXIDATION TEST RESULTS AT 1500°F OF THE
VARIOUS MoSi₂ BASE COATING SYSTEMS SILICONIZED
FOR VARIOUS TIME INTERVALS

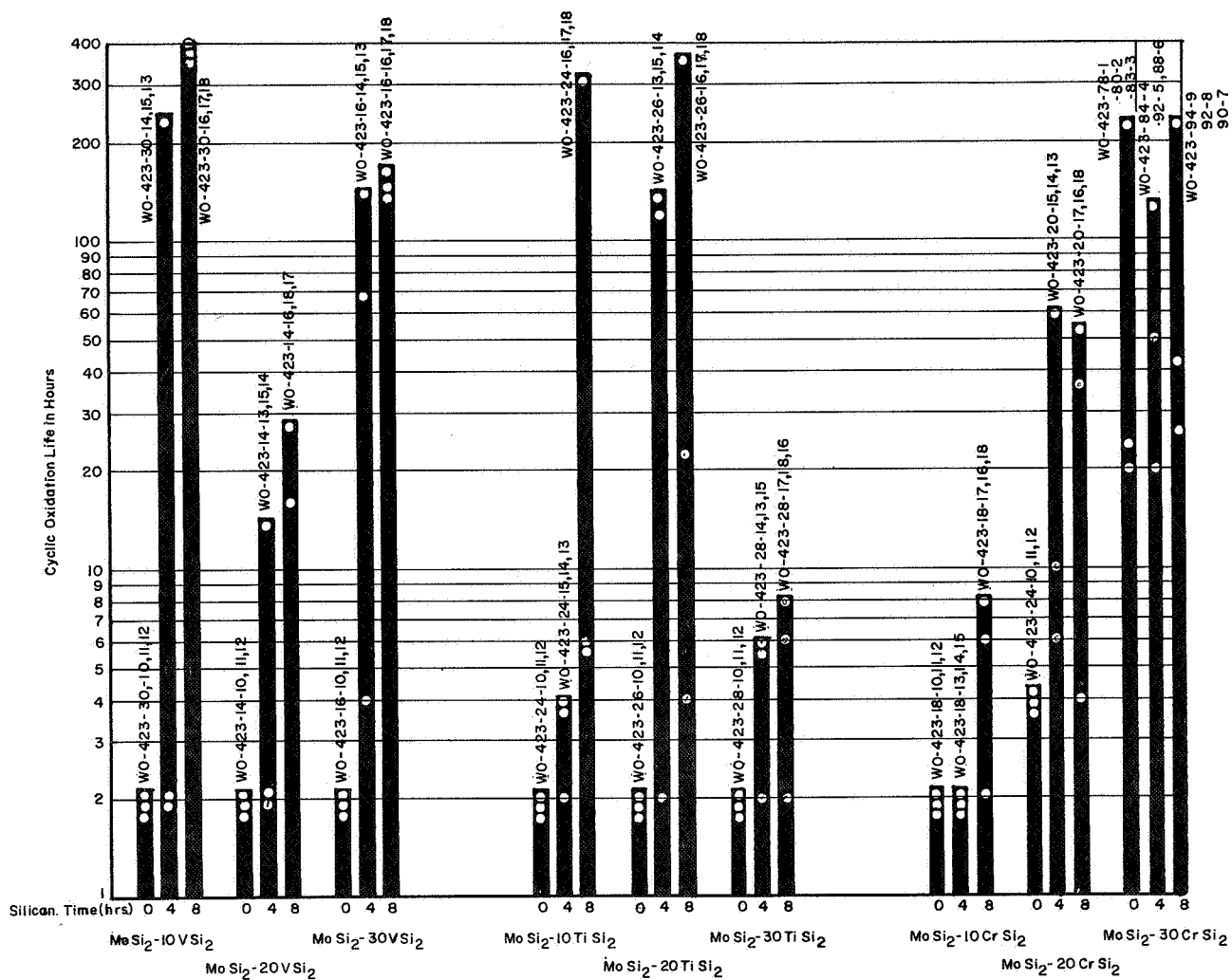
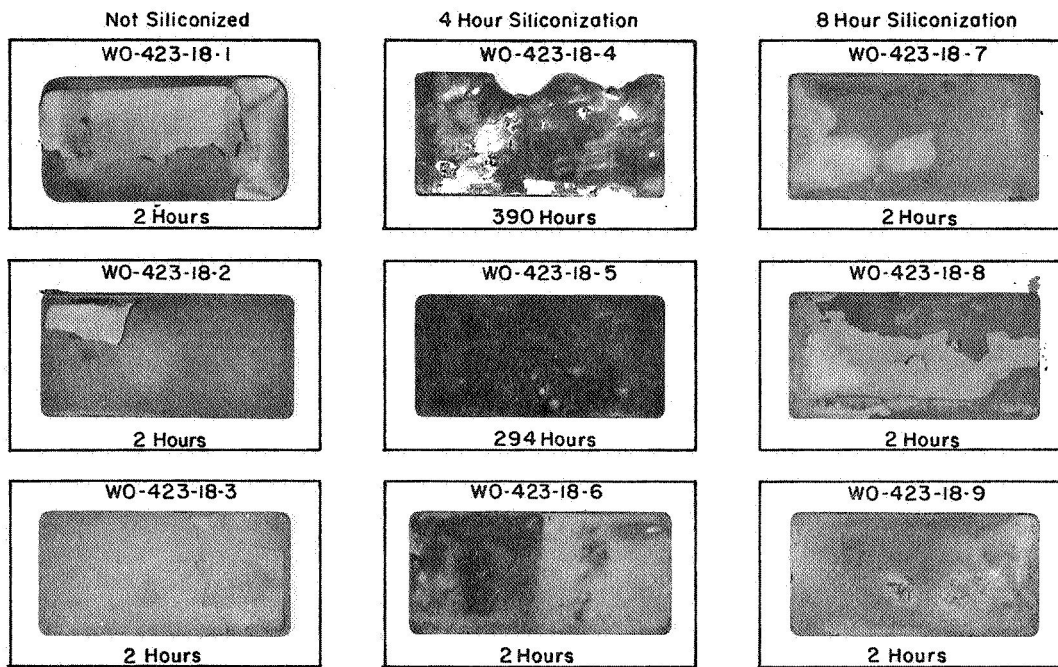


FIGURE 23

CYCLIC OXIDATION TEST RESULTS AT 2400°F OF THE
VARIOUS MoSi₂ BASE COATING SYSTEMS SILICONIZED
FOR VARIOUS TIME INTERVALS

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

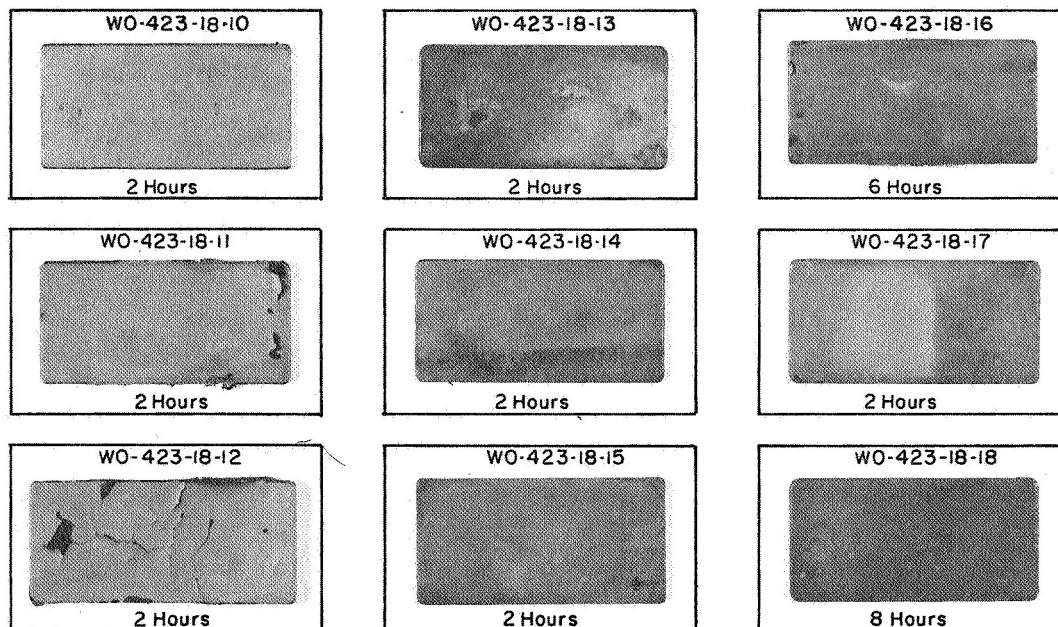
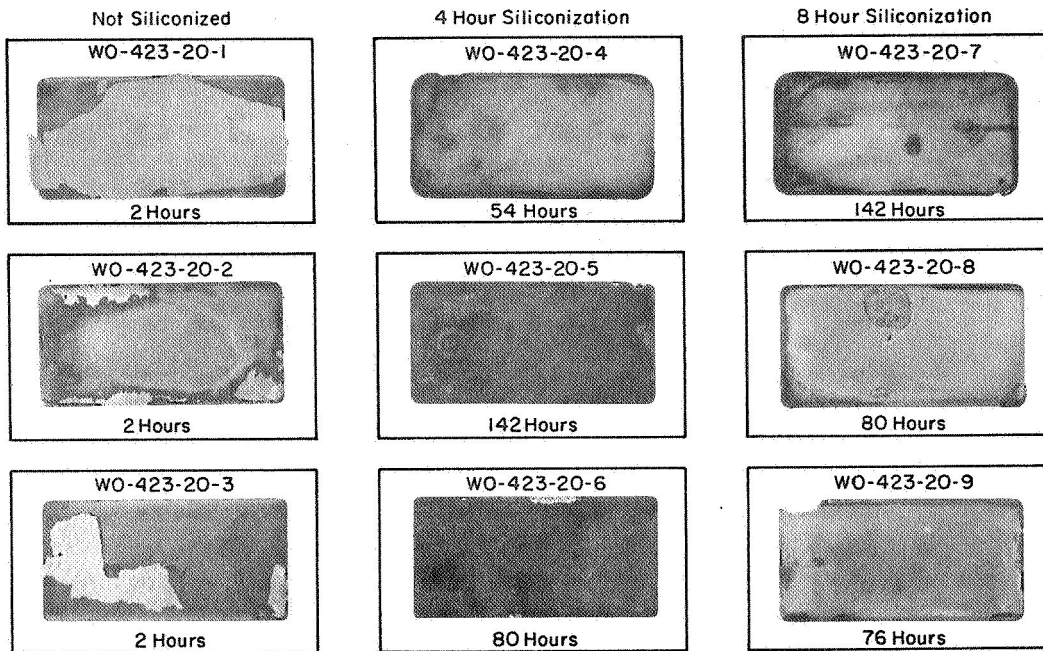


FIGURE 24

MoSi₂-10CrSi₂ COATED T-222 SPECIMENS SILICONIZED FOR VARIOUS TIME INTERVALS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

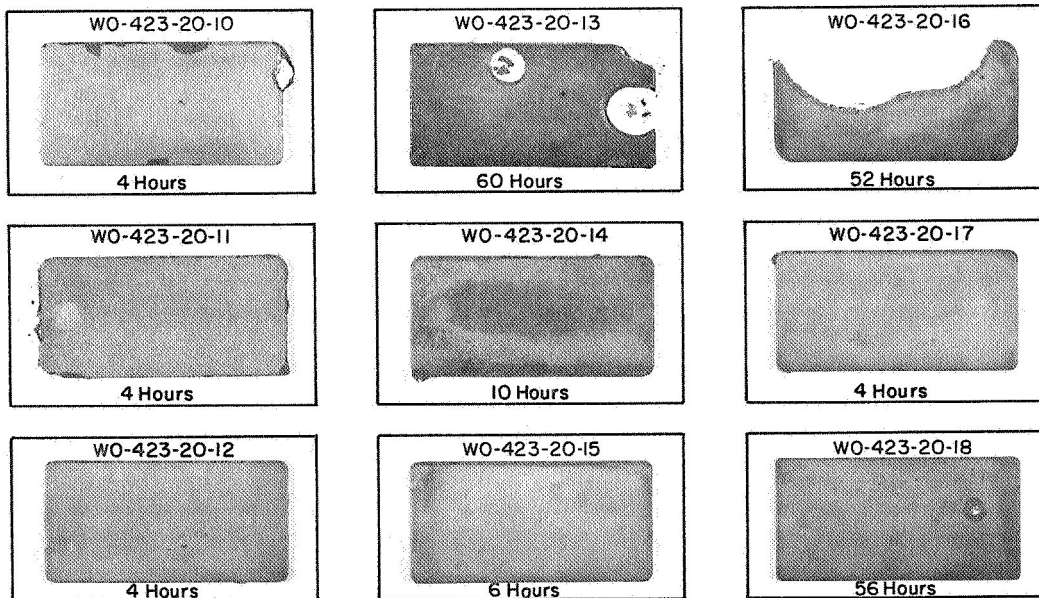
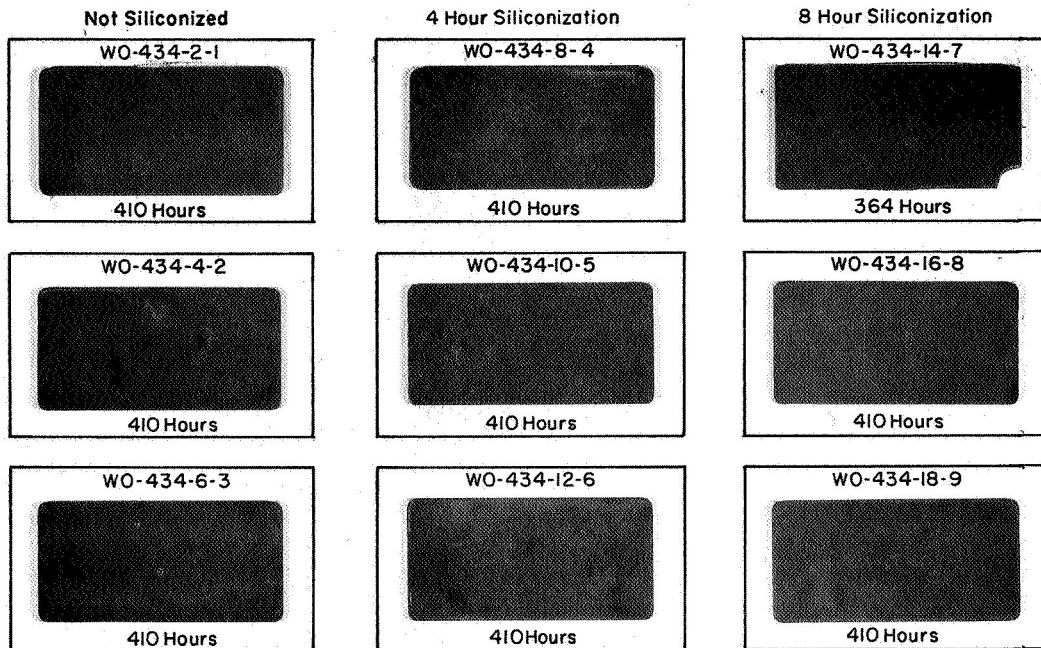


FIGURE 25

MoSi₂-20CrSi₂ COATED T-222, SILICONIZED FOR VARIOUS
TIME INTERVALS AND CYCLIC OXIDATION TESTED AT
1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

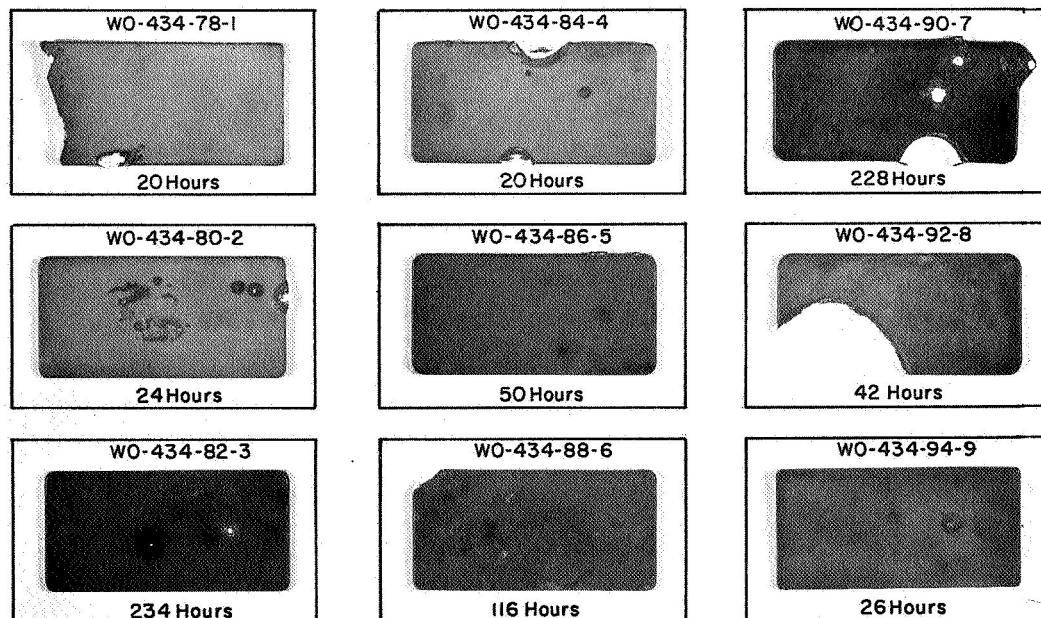
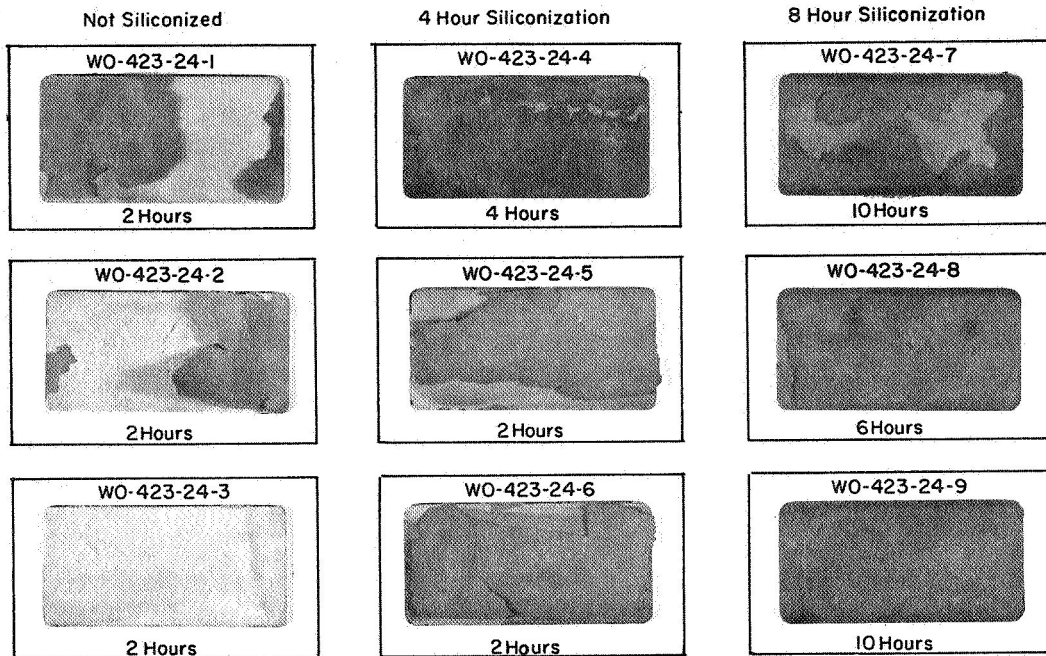


FIGURE 26

MoSi₂-20CrSi₂ COATED T-222, SILICONIZED FOR
 VARIOUS TIME INTERVALS AND CYCLIC OXIDATION
 TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

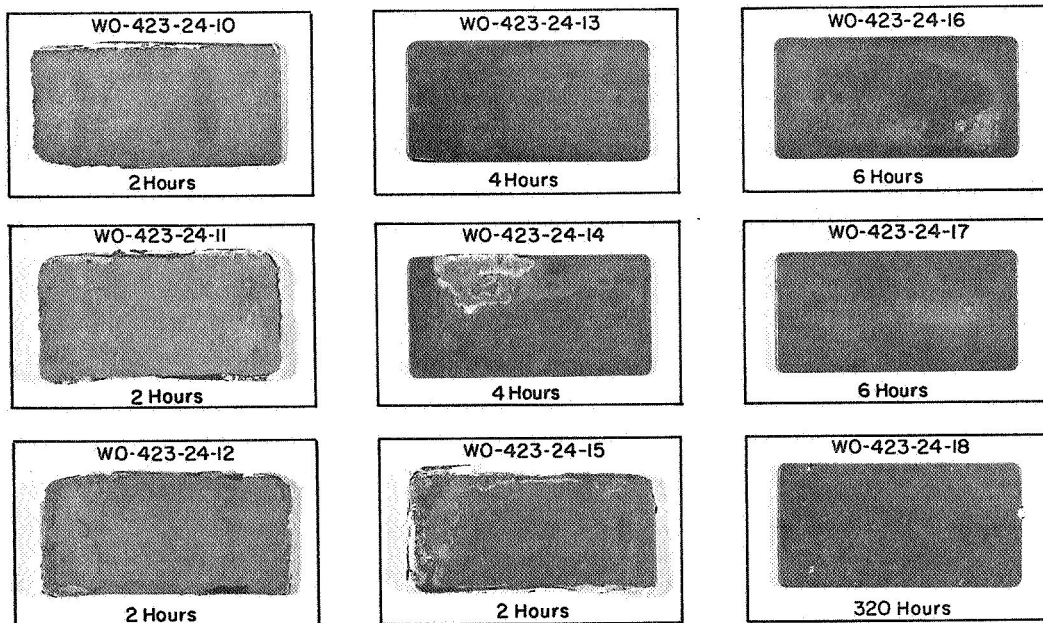


FIGURE 27

MoSi₂-10TiSi₂ COATED T-222, SILICONIZED FOR
VARIOUS TIME INTERVALS AND CYCLIC OXIDATION
TESTED AT 1500°F and 2400°F

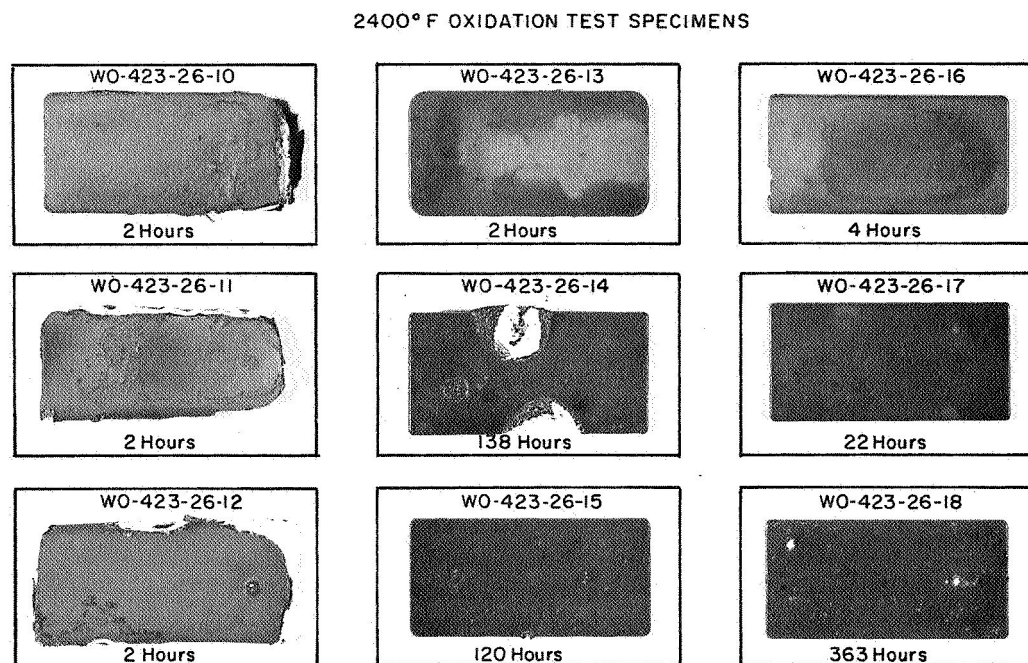
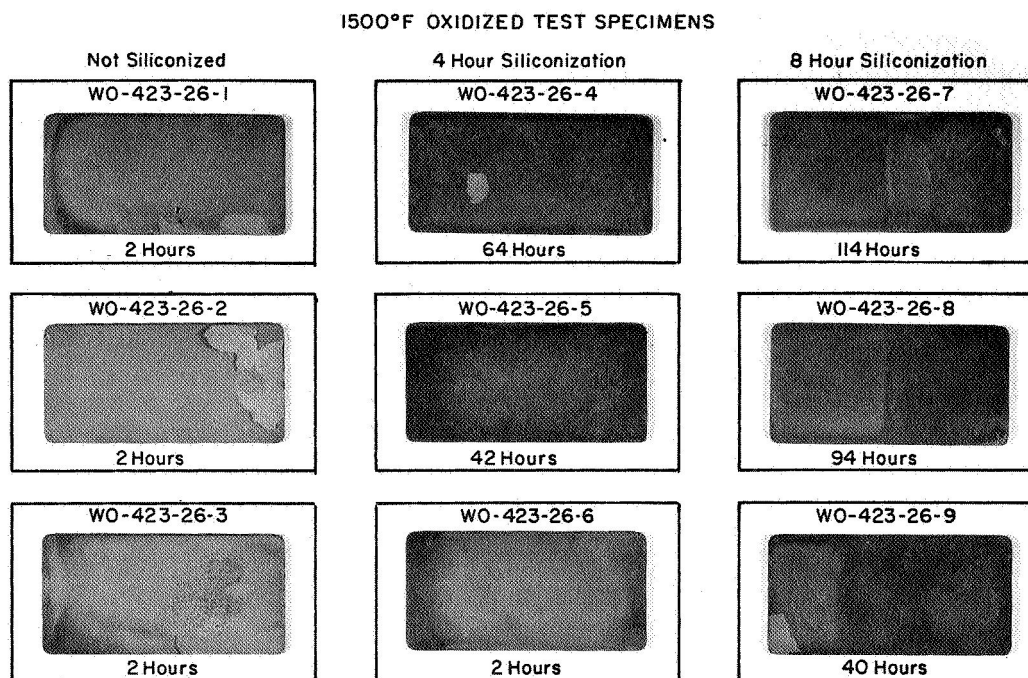
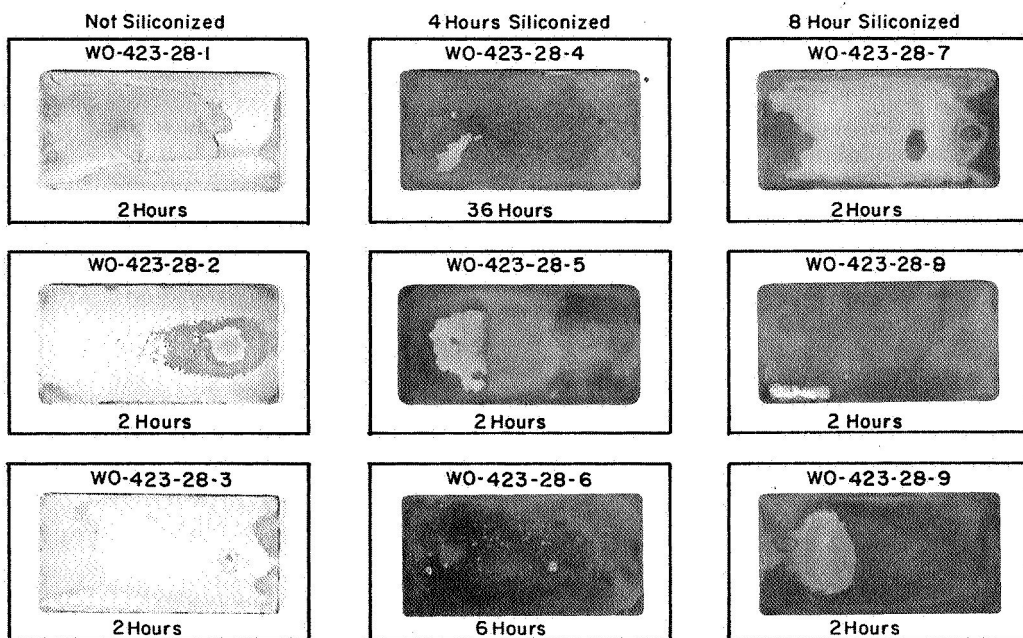


FIGURE 28

MoSi₂-20 TiSi₂ COATED T-222, SILICONIZED FOR VARIOUS
TIME INTERVALS AND CYCLIC OXIDATION TESTED AT
1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

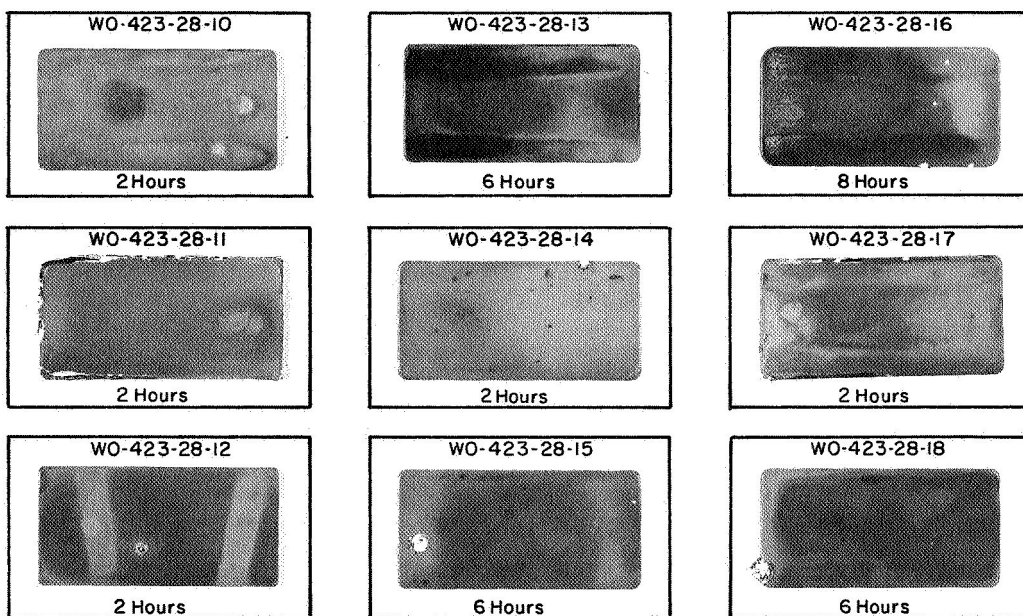
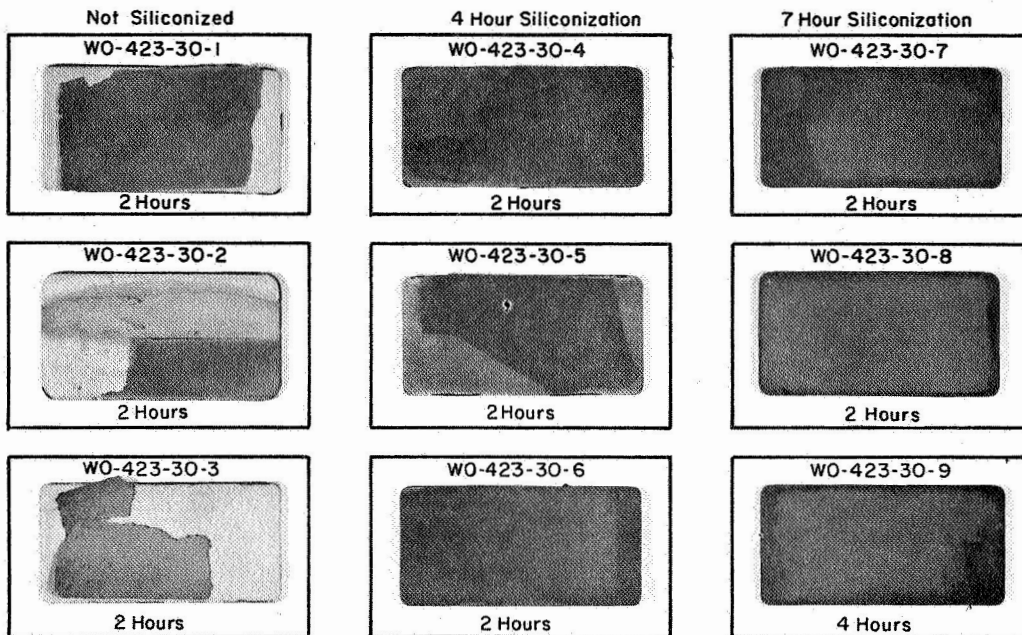


FIGURE 29

MoSi₂-30 TiSi₂ COATED T-222, SILICONIZED FOR VARIOUS
TIME INTERVALS AND CYCLIC OXIDATION TESTED AT
1500° F AND 2400° F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

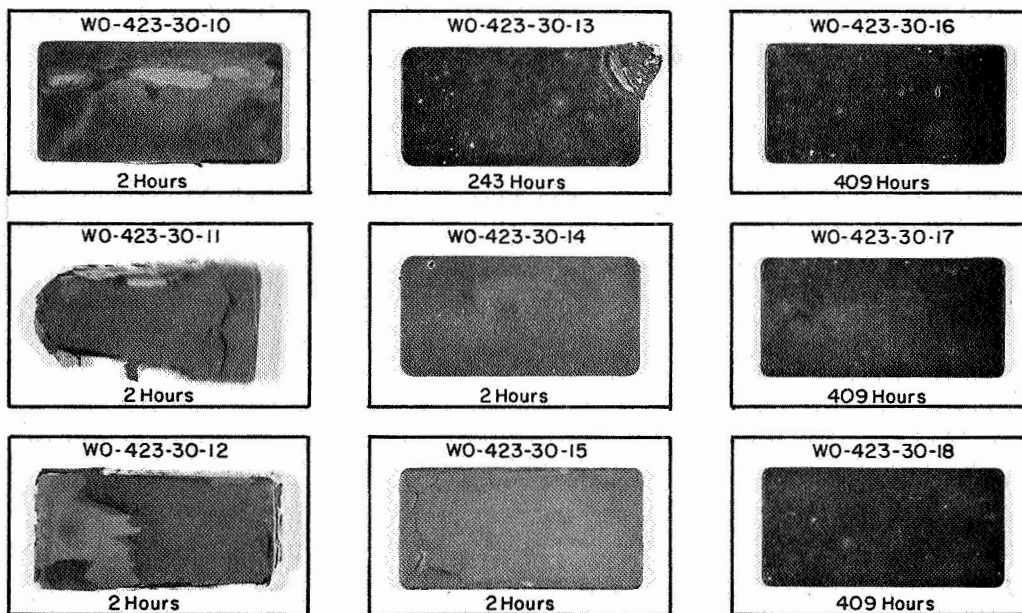
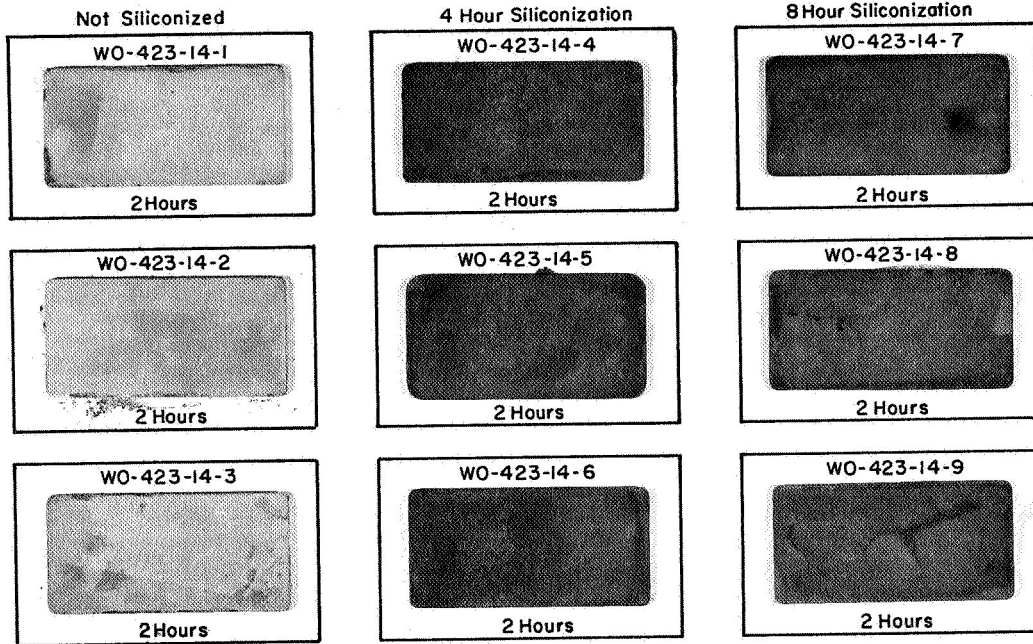


FIGURE 30

MoSi₂-10 VSi₂ COATED T-222, SILICONIZED FOR VARIOUS
TIME INTERVALS AND CYCLIC OXIDATION TESTED AT
1500°F AND 2400°F

1500° OXIDIZED TEST SPECIMENS



2400° OXIDIZED TEST SPECIMENS

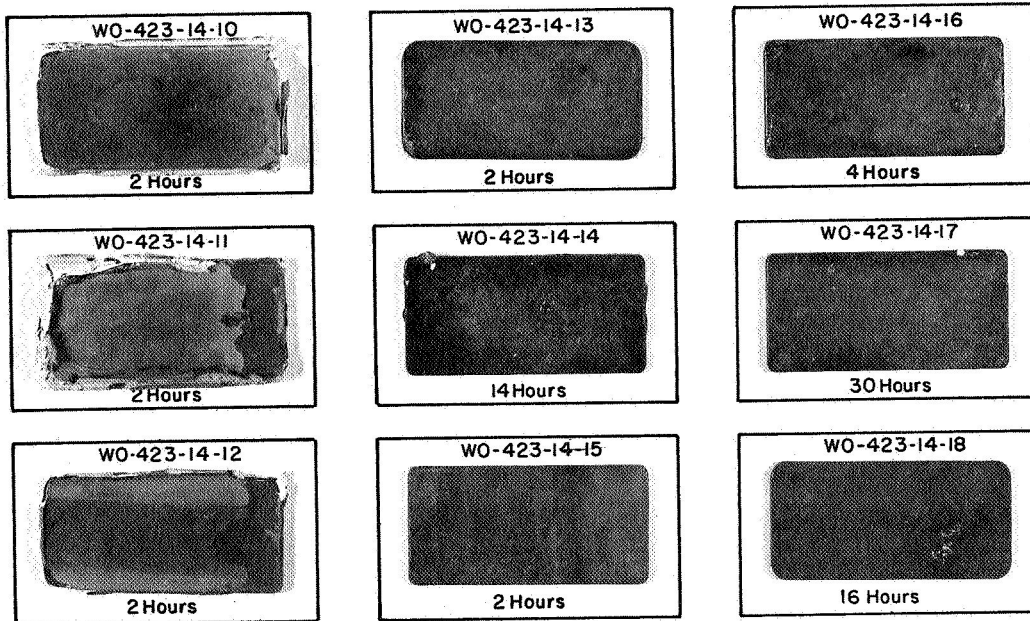
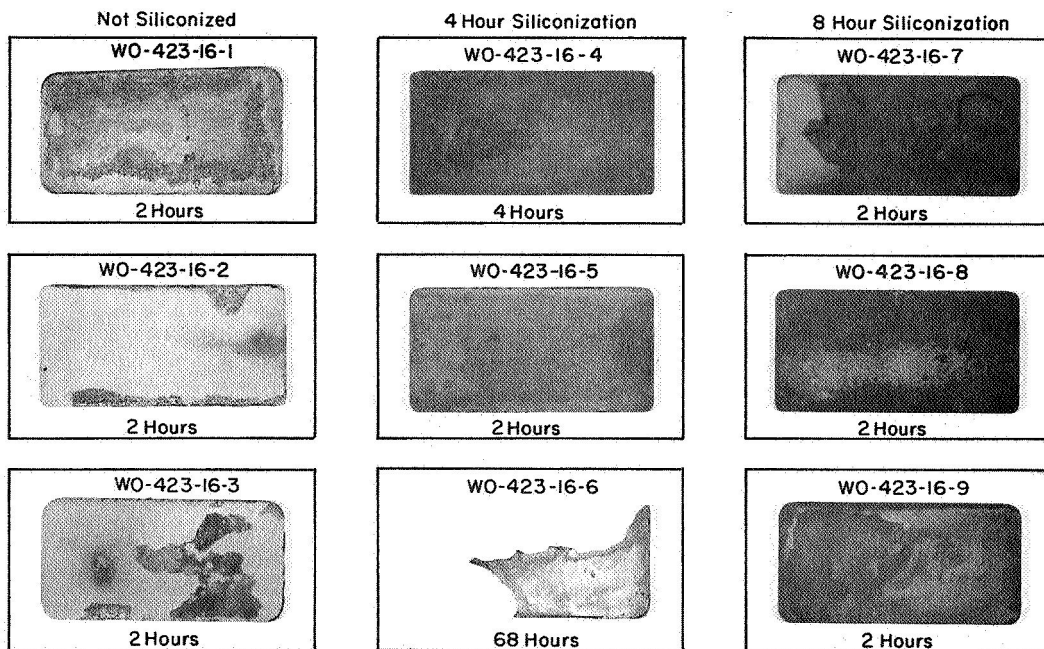


FIGURE 31

MoSi₂-20VSi₂ COATED T-222, SILICONIZED FOR VARIOUS
TIME INTERVALS AND CYCLIC OXIDATION TESTED AT
1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

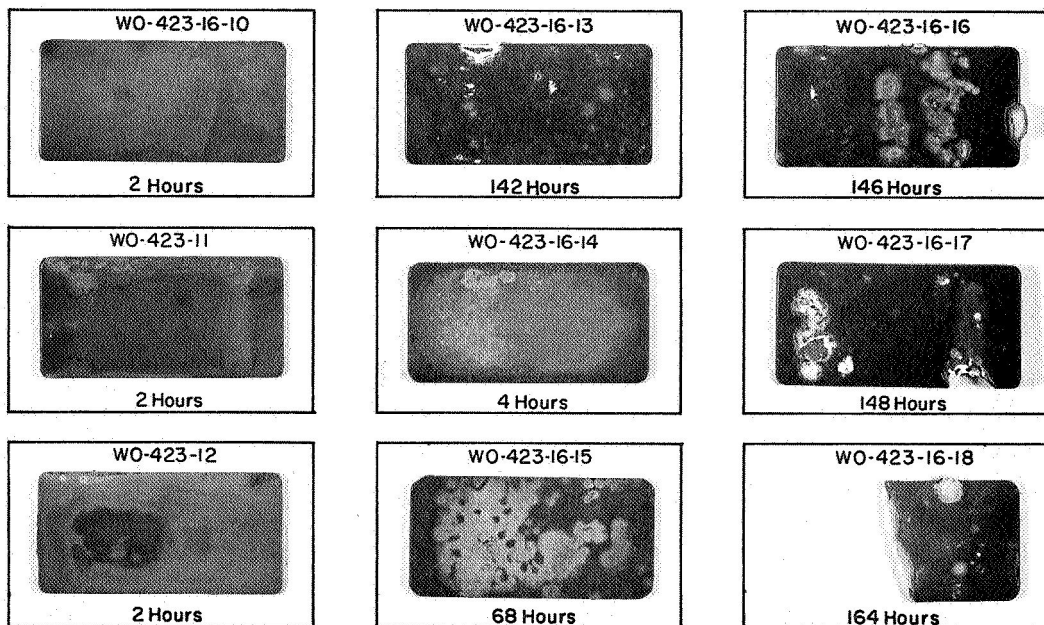


FIGURE 32

MoSi₂-30VSi₂ COATED T-222, SILICONIZED FOR VARIOUS
TIME INTERVALS AND CYCLIC OXIDATION TESTED AT
1500°F AND 2400°F

resistance of this particular coating system. All specimens of the three VSi_2 concentrations (10, 20 and 30%) that received no siliconization treatment failed after the first two (2) hour cycle. The oxidation performance of the MoSi_2 - TiSi_2 coating system was also improved by a siliconization treatment. In this case, an eight (8) hour siliconization treatment appeared optimum, particularly with the MoSi_2 -10 TiSi_2 and MoSi_2 -20 TiSi_2 coating systems. Also, at the optimum siliconization condition and taking into account both test temperatures (1500°F and 2400°F) an optimum TiSi_2 concentration level of 20% was indicated. Oxidation lives of 115 hours and 360 hours at 2400°F were realized. The non-siliconized specimens at the three TiSi_2 concentration levels failed after the first two hour test cycle. Again, a general type of failure was noted with the non-siliconized specimens.

In examining the silicon weight gain data obtained for each specimen, considerable scatter was noted which precluded any correlation with oxidation resistance.

3.3.2 Oxidation Tests of Double-Coated Silicide Systems

For this evaluation the MoSi_2 -10 VSi_2 , MoSi_2 -20 TiSi_2 and MoSi_2 -30 CrSi_2 coating systems were used on the basis of their performance in previous tests. Three coated specimens of each coating system were tested under cyclic conditions at 1500°F and 2400°F. The results are tabulated in Appendix A (pages A-28 to A-30) and summarized in Figure 33. Photographs of the tested specimens are shown in Figures 34 to 36.

As indicated by the test results no improvement in oxidation life was obtained for the double coating systems. In fact, a single layer coating for each of the systems tested exhibited better oxidation resistance than the double layer coating. Microscopic examination of the double coated specimen failed to reveal the cause of premature coating failure. Of the eighteen specimens tested at 1500°F and 2400°F (6 for each coating system) sixteen failed after 2 - 48 hours of testing. Only one specimen from the MoSi_2 -30 CrSi_2 coating system survived the 400 hour test at 1500°F. The remaining specimen failed after 94 hours of testing at 2400°F.

3.3.3 Oxidation Tests of Preoxidized Silicide Coating Systems

In these tests, the effect of preoxidation on the oxidation behavior of the 8 hour-siliconized MoSi_2 -10 VSi_2 , MoSi_2 -20 TiSi_2 , and MoSi_2 -30 CrSi_2 coatings and the 16 hour-siliconized MoSi_2 -30 CrSi_2 coating systems was determined. The 16 hour-siliconized MoSi_2 -30 CrSi_2 coating system was included in this

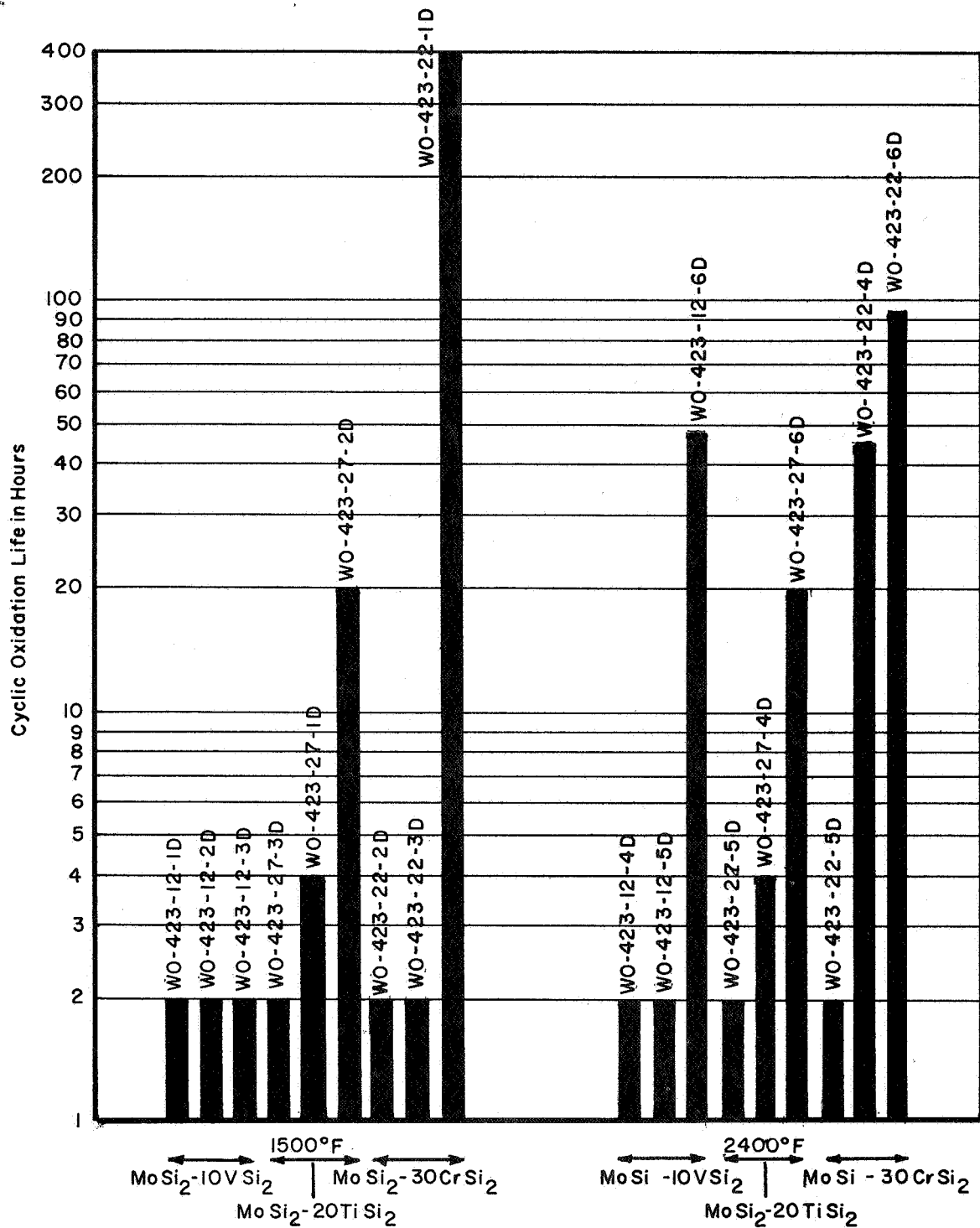
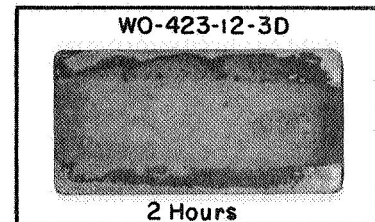
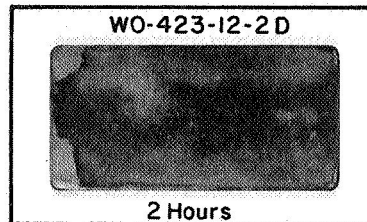
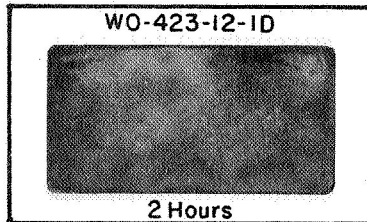


FIGURE 33

CYCLIC OXIDATION TEST RESULTS OF THE MoSi₂-10VSi₂,
MoSi₂-20TiSi₂ AND MoSi₂-30CrSi₂ DOUBLE COATED
T-222 SPECIMENS SILICONIZED FOR 8 HOURS

1500°F OXIDIZED TEST SPECIMENS

8 Hour Siliconization



2400°F OXIDIZED TEST SPECIMENS

8 Hour Siliconization

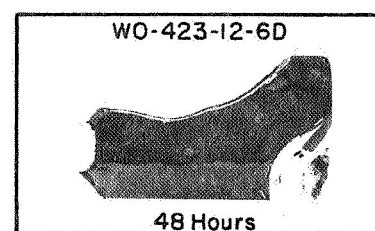
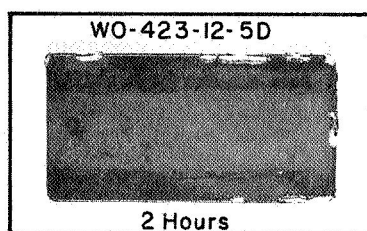
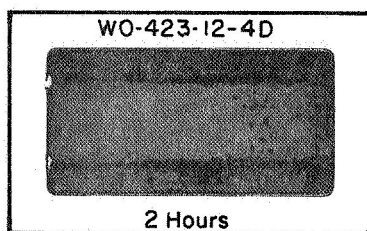
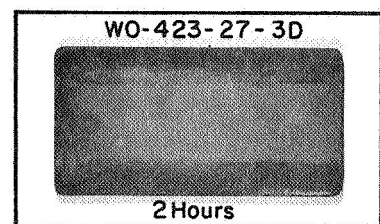
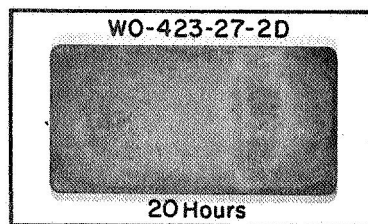
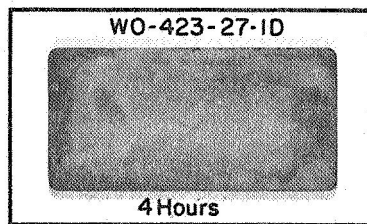


FIGURE 34

MoSi₂-10VSi₂ DOUBLE COATED T-222 SPECIMENS SILICONIZED FOR 8 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS
8 Hour Siliconization



2400°F OXIDIZED TEST SPECIMENS
8 Hour Siliconization

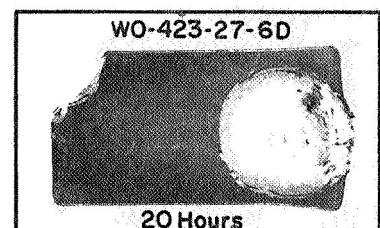
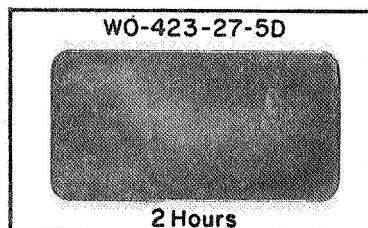
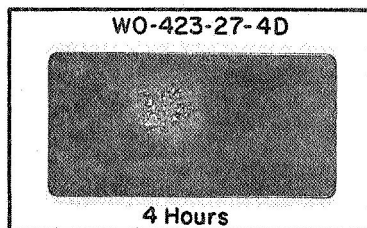
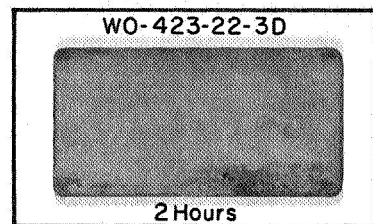
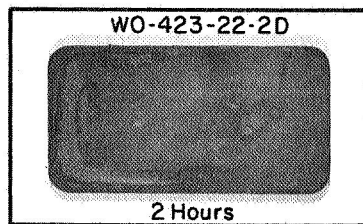
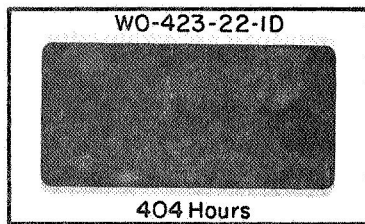


FIGURE 35

MoSi₂-20TiSi₂ DOUBLE COATED T-222 SPECIMENS SILICONIZED FOR
8 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS
8 Hour Siliconization



2400°F OXIDIZED TEST SPECIMENS
8 Hour Siliconization

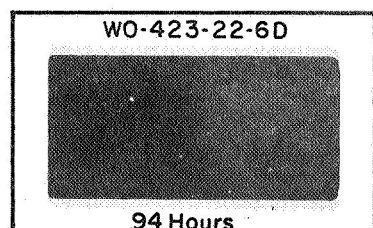
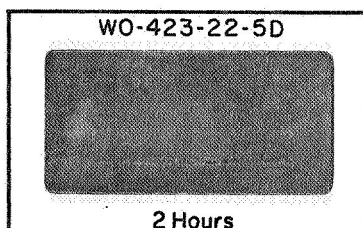
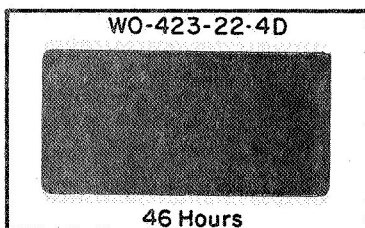


FIGURE 36

MoSi₂-30CrSi₂ DOUBLE COATED T-222 SPECIMENS SILICONIZED FOR
8 HOURS AND CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

investigation to determine the effect of combining a longer siliconizing treatment with preoxidation. In this study, preoxidation conditions of 30 minutes at 2730°F and 5, 15, and 30 minutes at 2910°F were examined. Specimen weight gain (mg/cm²) was determined before and after siliconizing and at each preoxidizing time interval (5, 10, and 30 minutes) at 2910°F. Three specimens from each coating combination were then oxidation tested at 1500°F and 2400°F. The results of these tests are summarized in Figures 37 to 38 and tabulated in Appendix A (pages A-31 to A-44). Photographs of each specimen after testing are shown in Figures 39 to 45.

The results of the oxidation tests indicate that preoxidation at the various time and temperature levels was not effective in improving the oxidation resistance of these silicide coating systems. The results were comparable to previous results obtained on specimens of the same coating system that were not preoxidized. The maximum oxidation life obtained for each coating system at 1500°F and 2400°F was as follows:

Coating System	Preoxidation Conditions	Oxidation Life (hrs)	
		1500°F	2400°F
MoSi ₂ -10VSi ₂	5 minutes @ 2910°F	2	209
MoSi ₂ -10VSi ₂	15 minutes @ 2910°F	2	318
MoSi ₂ -10VSi ₂	30 minutes @ 2910°F	2	392
MoSi ₂ -10VSi ₂	30 minutes @ 2700°F	22	22
MoSi ₂ -20TiSi ₂	5 minutes @ 2910°F	69	162
MoSi ₂ -20TiSi ₂	15 minutes @ 2910°F	89	26
MoSi ₂ -20TiSi ₂	30 minutes @ 2910°F	22	183
MoSi ₂ -20TiSi ₂	30 minutes @ 2700°F	22	118
MoSi ₂ -30CrSi ₂ *	5 minutes @ 2910°F	164	139
MoSi ₂ -30CrSi ₂	5 minutes @ 2910°F	460	142
MoSi ₂ -30CrSi ₂ *	15 minutes @ 2910°F	46	139
MoSi ₂ -30CrSi ₂	15 minutes @ 2910°F	209	45
MoSi ₂ -30CrSi ₂	30 minutes @ 2910°F	115	24
MoSi ₂ -30CrSi ₂	30 minutes @ 2700°F	185	115

* Coating system siliconized for 16 hours at 2370°F under reduced pressure.

As before, the MoSi₂-30CrSi₂ coating system exhibited the best oxidation resistance at 1500°F while the MoSi₂-10VSi₂ coating system yielded the best oxidation resistance at 2400°F.

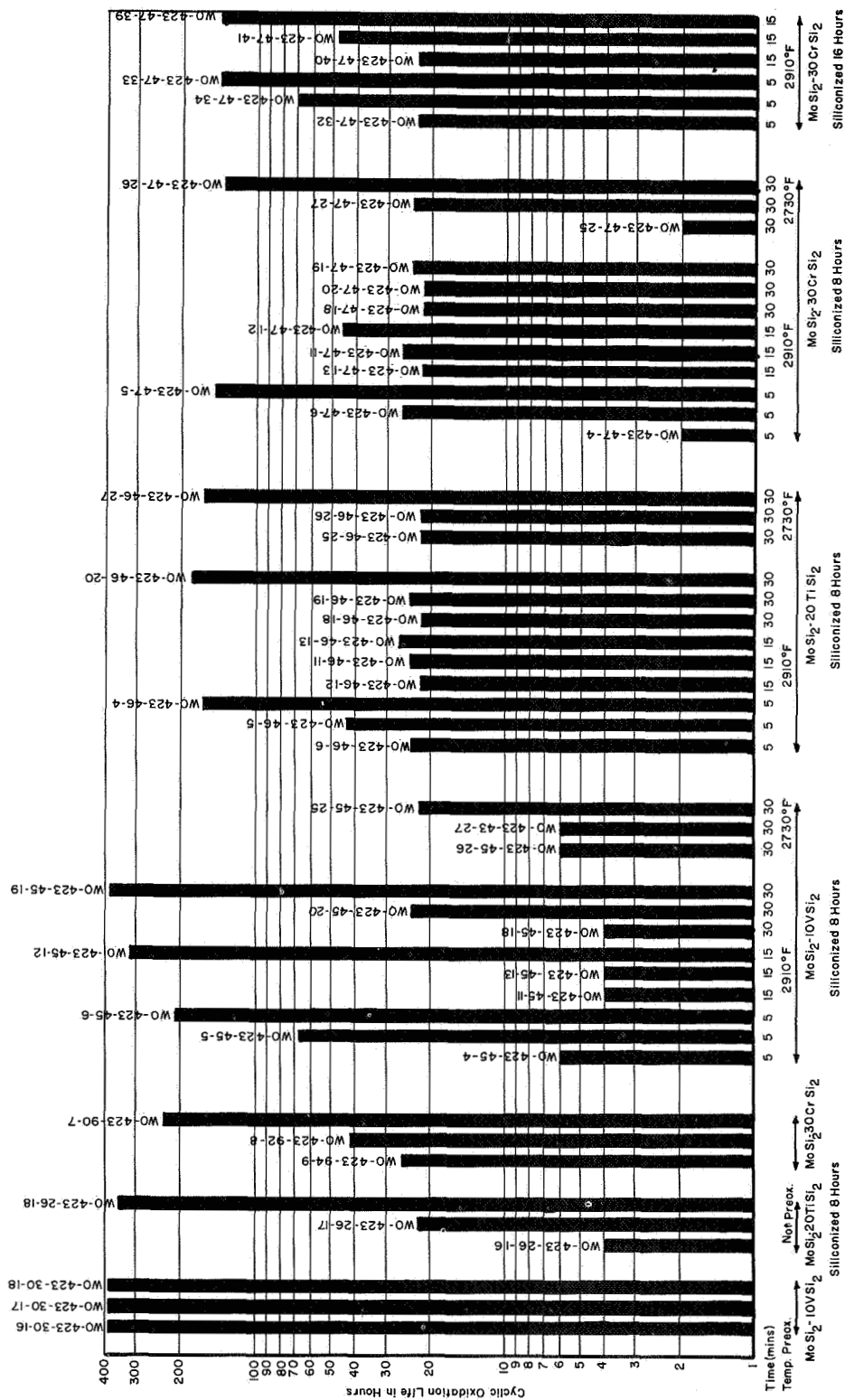
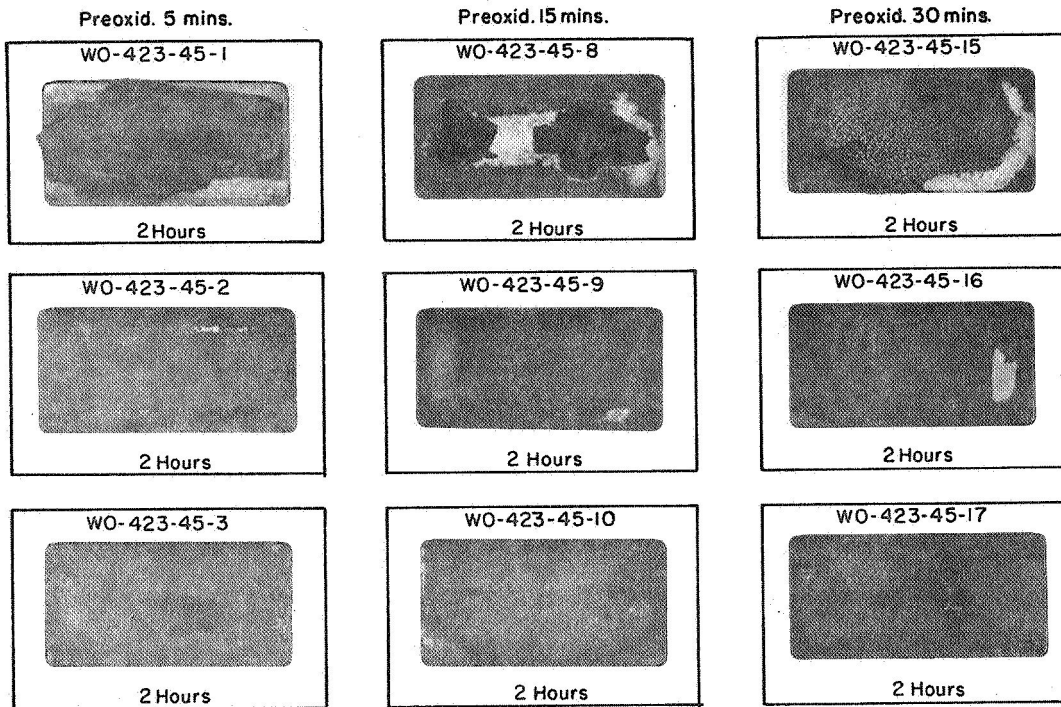


FIGURE 38

CYCLIC OXIDATION TEST RESULTS AT 2400°F OF THE VARIOUS
SILICIDE COATED T-222 SPECIMENS PREOXIDIZED AT
2730°F AND 2910°F FOR VARIOUS TIME INTERVALS

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

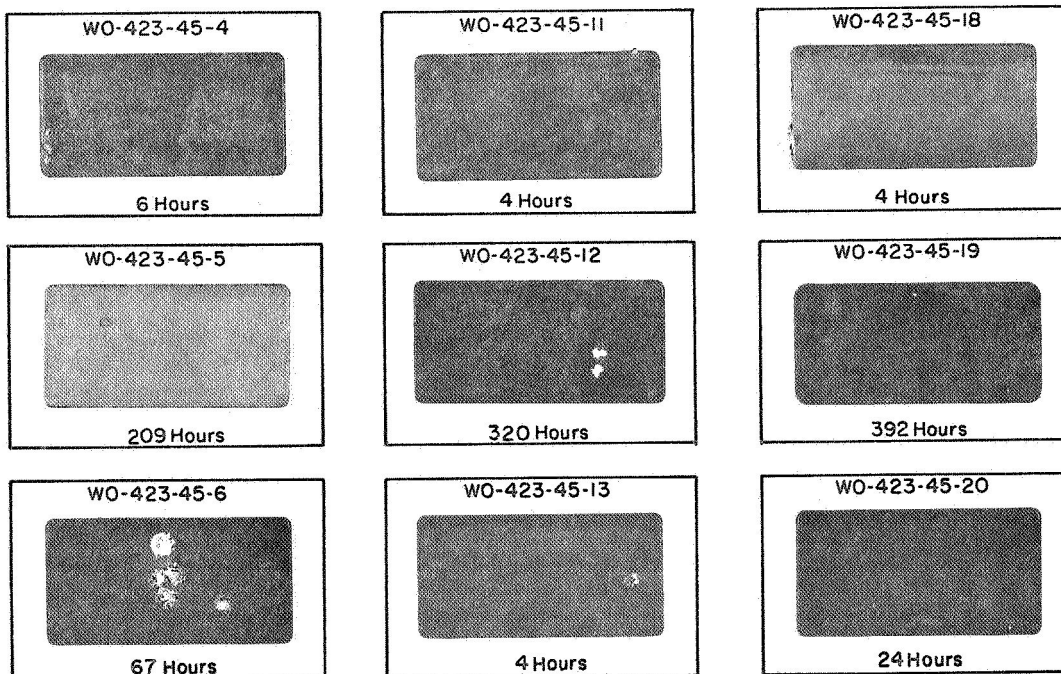
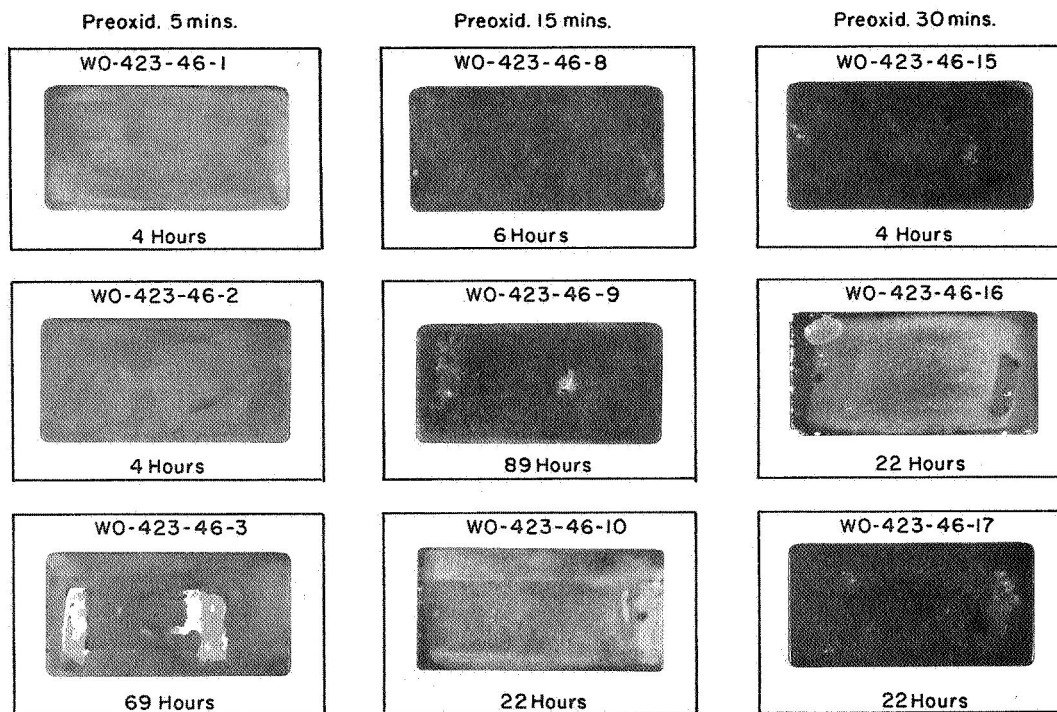


FIGURE 39

MoSi₂-10VSi₂ COATED T-222 PREOXIDIZED AT 2910°F FOR
VARIOUS TIME INTERVALS AND CYCLIC OXIDATION
TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

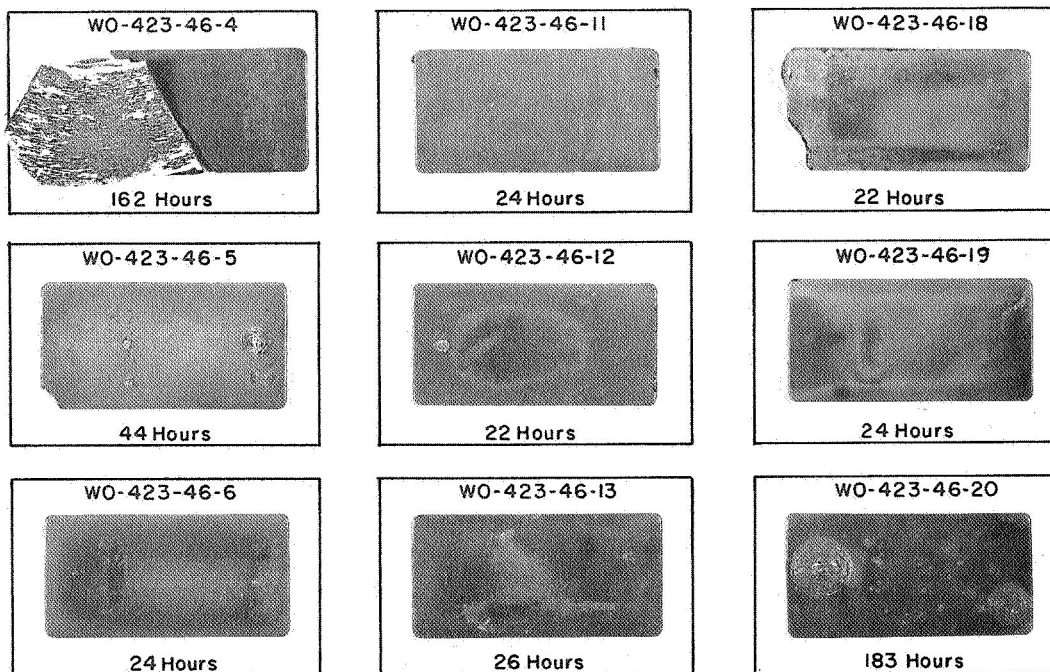
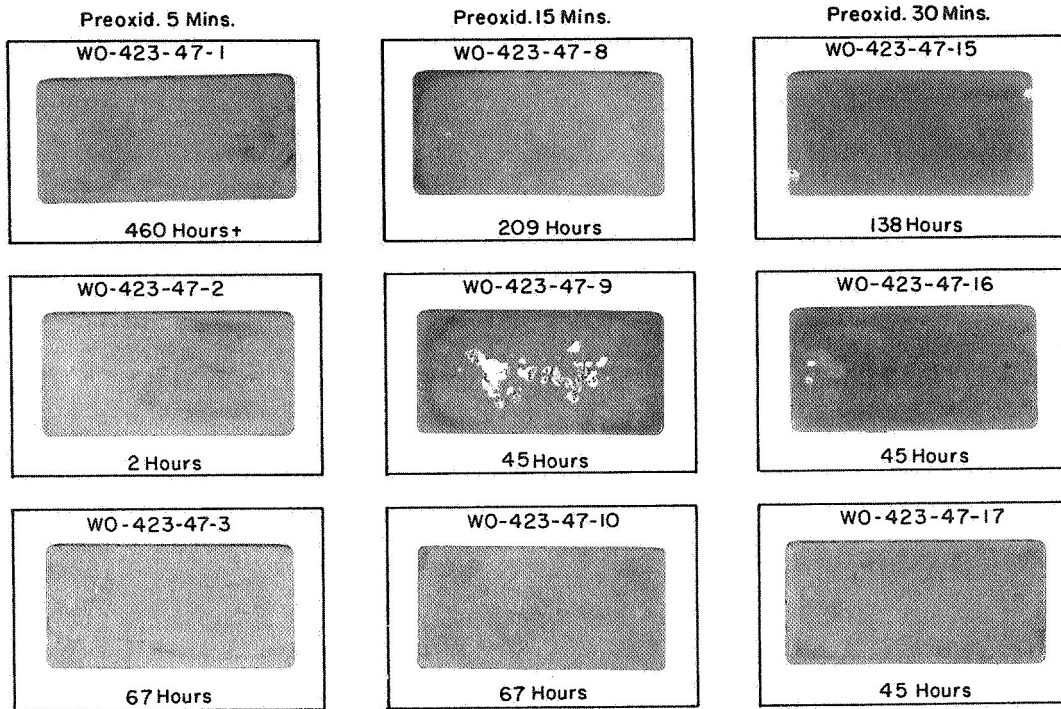


FIGURE 40

MoSi₂-20TiSi₂ COATED T-222 PREOXIDIZED AT 2910°F FOR
VARIOUS TIME INTERVALS AND CYCLIC OXIDATION
TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

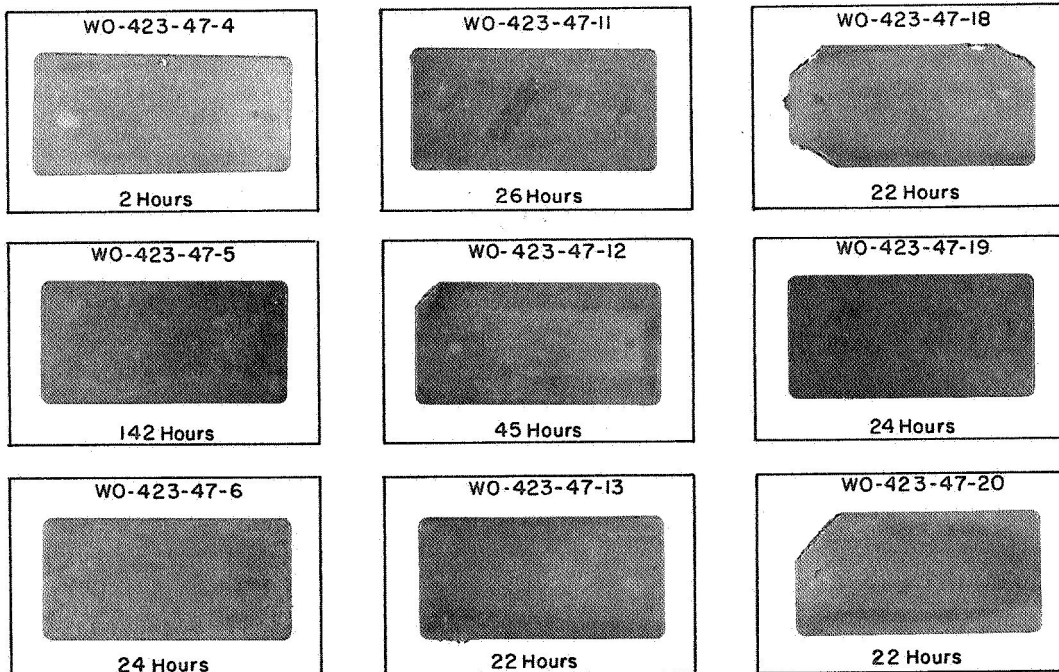
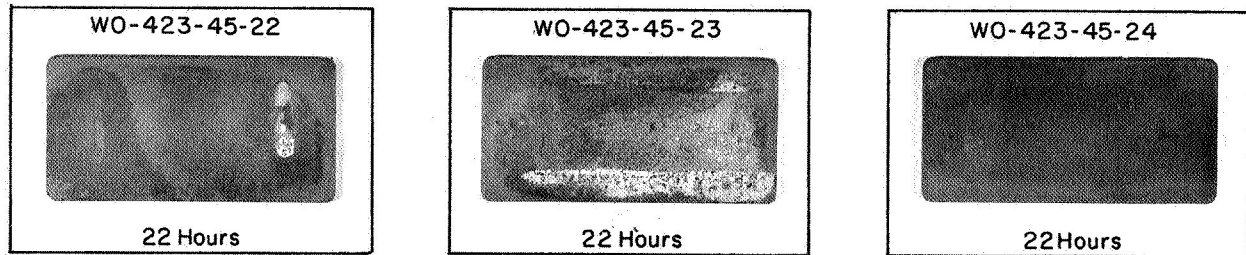


FIGURE 41

MoSi₂-30CrSi₂ COATED T-222 PREOXIDIZED AT 2910°F FOR
VARIOUS TIME INTERVALS AND CYCLIC OXIDATION
TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

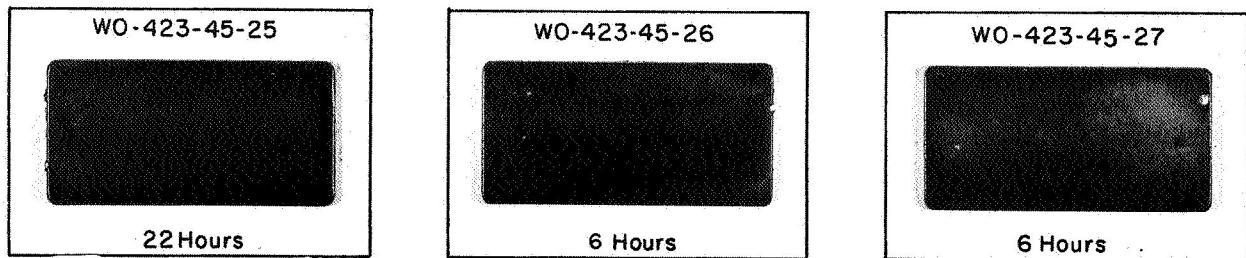
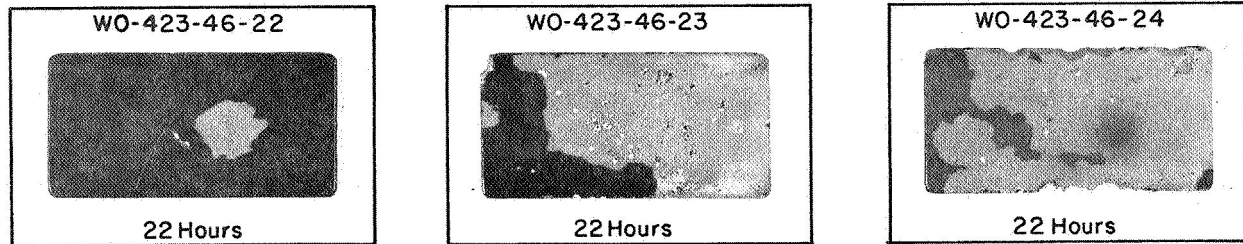


FIGURE 42

MoSi₂-10VSi₂ COATED T-222 PREOXIDIZED AT 2730°F
FOR 30 MINUTES AND CYCLIC OXIDATION TESTED
AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

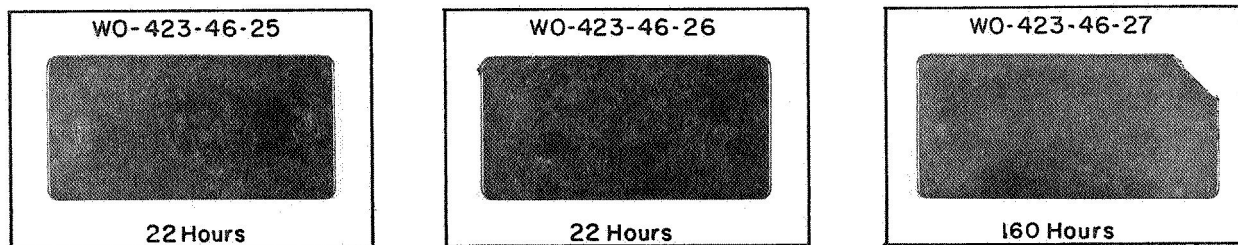
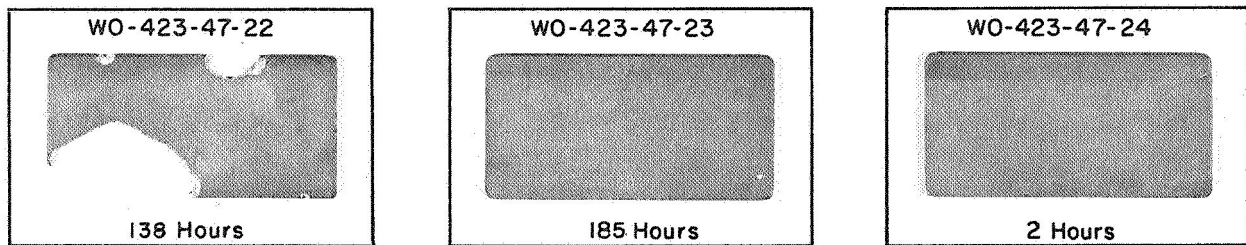


FIGURE 43

MoSi₂-20TiSi₂ COATED T-222 PREOXIDIZED AT 2730°F
FOR 30 MINUTES AND CYCLIC OXIDATION TESTED
AT 1500°F AND 2400°F

1500° F OXIDIZED TEST SPECIMENS



2400° F OXIDIZED TEST SPECIMENS

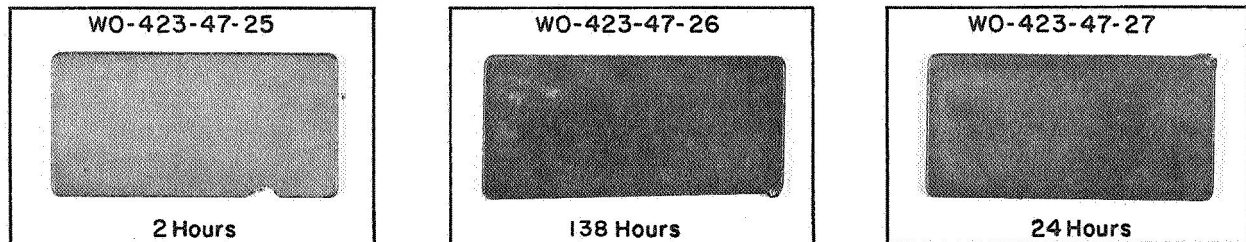
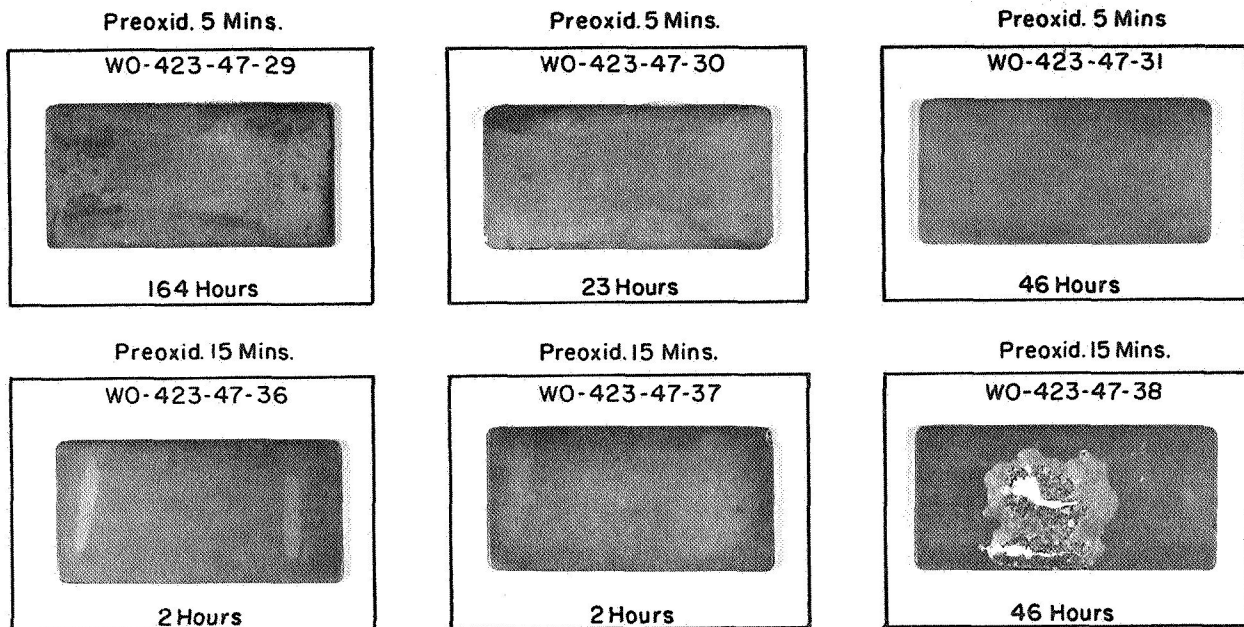


FIGURE 44

MoSi₂-30CrSi₂ COATED T-222 PREOXIDIZED AT 2730° F.
FOR 30 MINUTES AND CYCLIC OXIDATION TESTED
AT 1500° F AND 2400° F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

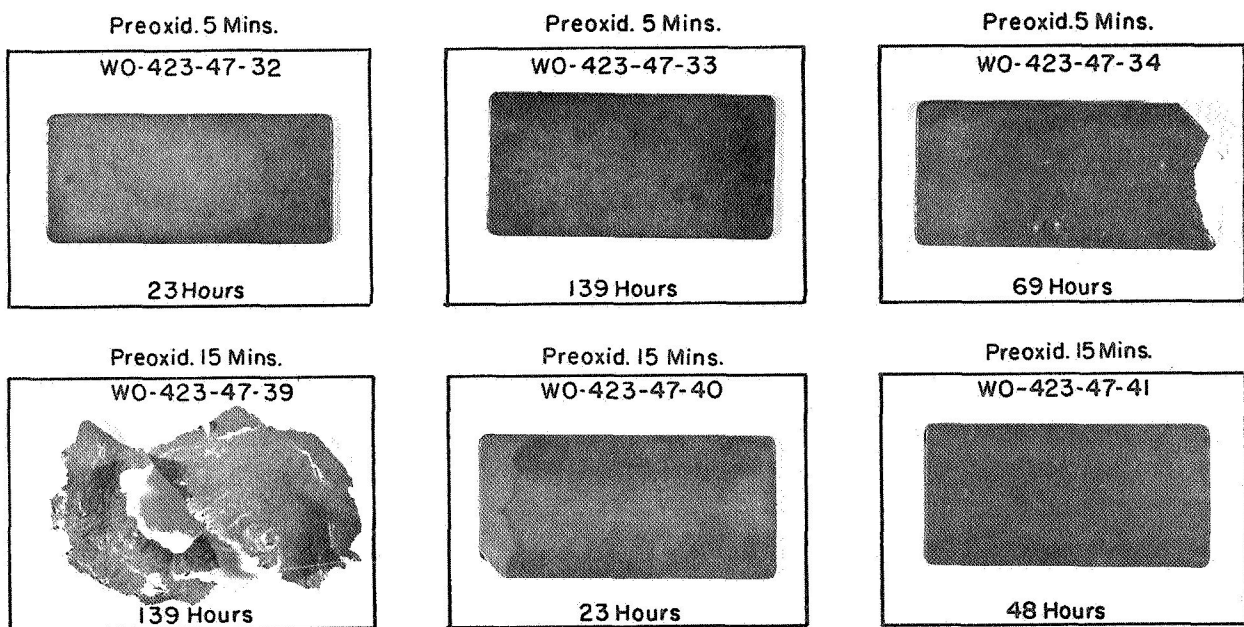


FIGURE 45

MoSi₂-30CrSi₃ COATED T-222 SPECIMENS SILICONIZED
FOR 16 HOURS PREOXIDIZED AT 2910° F FOR VARIOUS
TIME INTERVALS AND CYCLIC OXIDATION TESTED AT
1500° F AND 2400° F

3.4.4 Oxidation Tests of the Siliconized Mo-15.4Ti Coating System

In an effort to improve the coating reliability of the MoSi₂ base coating systems, an attempt was made to prepare the MoSi₂-20TiSi₂ coating system by a technique whereby the density of the coating could be increased and thus possibly result in improved oxidation resistance. In this approach molybdenum and titanium metal powders were codeposited from a Mo-15.4%Ti metal powder dispersion, densified at 30 tsi, and sintered at 2910°F for 3 hours under reduced pressure (0.01 micron). A duplicate set of test specimens was also sintered at 3630°F for the same interval. All specimens were siliconized for 16 hours at 2370°F under reduced pressures and then cyclic oxidation tested at 1500°F and 2400°F. The results of these tests are tabulated in Appendix A (pages A-45 to A-47) and also shown in Figure 46. Photographs of the tested specimens are shown in Figures 47 and 48.

Photomicrographs depicting the coating structure of the sintered and siliconized coatings are shown in Figures 49 and 50.

As the results indicate, improvement in oxidation behavior over previously tested specimens of the MoSi₂-20TiSi₂ coating system was not obtained. The only difference observed in this series of tests was between the 2910°F and 3630°F sintered specimens. Longer lives (68-416 hours) were obtained at 1500°F on specimens that were sintered at the higher temperature (3630°F). The maximum life achieved with the 2910°F sintered specimens at the 1500°F test temperature was 23 hours.

At 2400°F all of the specimens with the exception of one failed between the first and third 2-hour cycle. The longer-lived specimen, which was sintered at the higher sintering temperature, failed after 92 hours of testing. These results indicated that a denser coating structure was ineffective in extending the oxidation life of the MoSi₂-20TiSi₂ coating system.

3.3.5 Oxidation Tests of the CrSi₂-20TiSi₂ Binary and MoSi₂-15CrSi₂-15VSi₂ Ternary Coating System

In another approach to meet the program objective, prealloyed CrSi₂-20VSi₂ and MoSi₂-15CrSi₂-15VSi₂ systems were investigated for protecting tantalum alloy. Coatings for these systems were prepared by sintering the densified, electrophoretically deposited coating at 2910°F for 1 hour under argon and subsequently siliconizing at 2370°F for 8 hours under reduced pressure. Photomicrographs showing the coating structure of these two systems are shown in Figures 51 and 52. For these tests, six (6) specimens of each

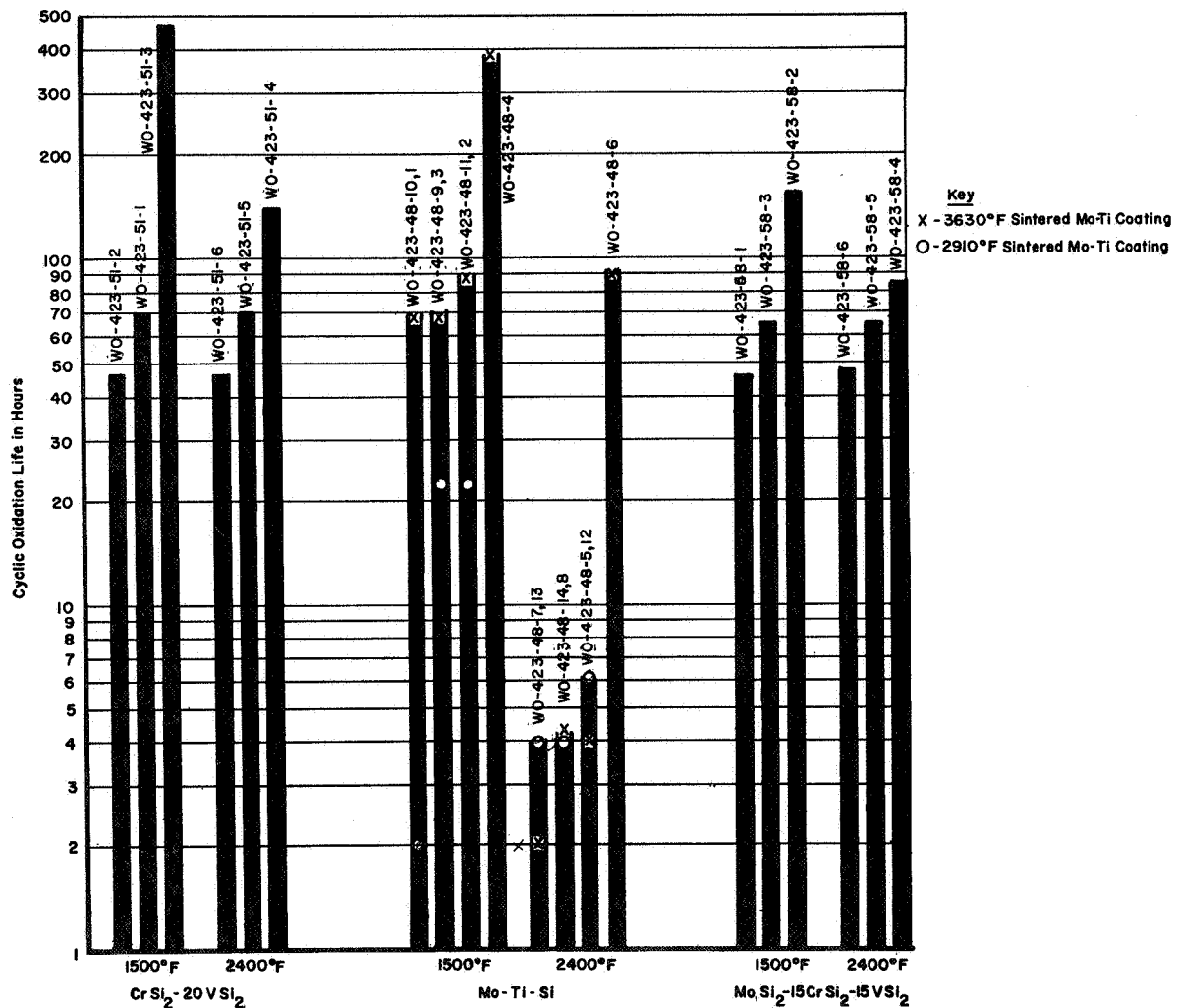
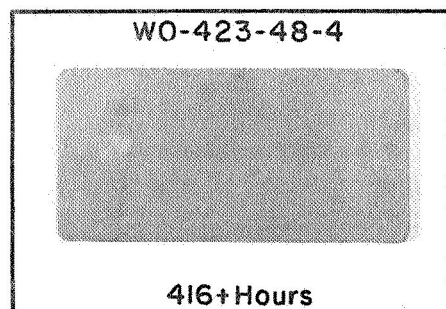
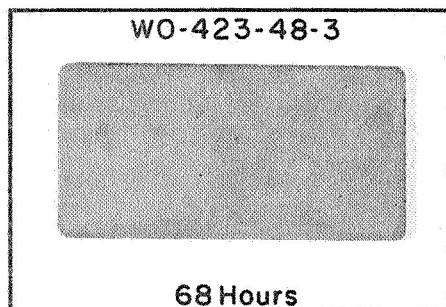
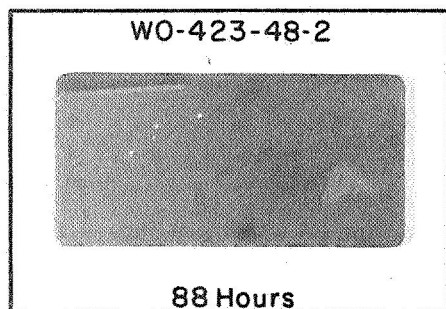
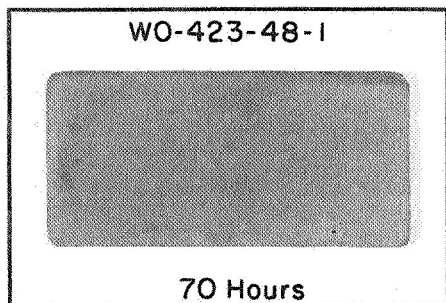


FIGURE 46

CYCLIC OXIDATION TEST RESULTS OF THE CrSi₂-20VSi₂,
MoSi₂-15CrSi₂-15VSi₂ AND THE Mo-15.4Ti-Si COATED
T-222 SPECIMENS

1500°F
OXIDIZED TEST SPECIMENS



2400°F
OXIDIZED TEST SPECIMENS

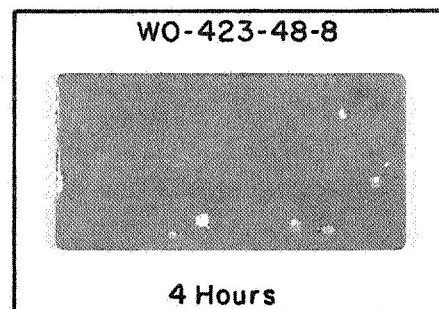
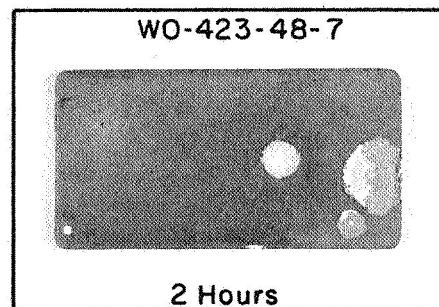
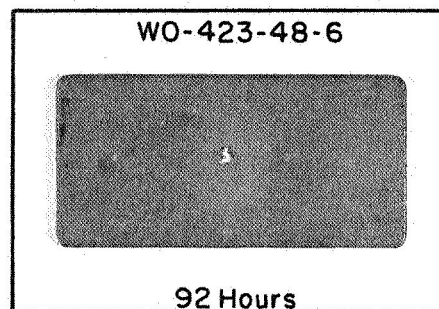
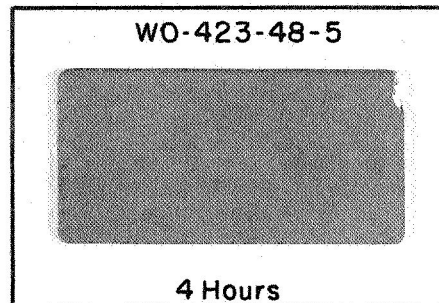
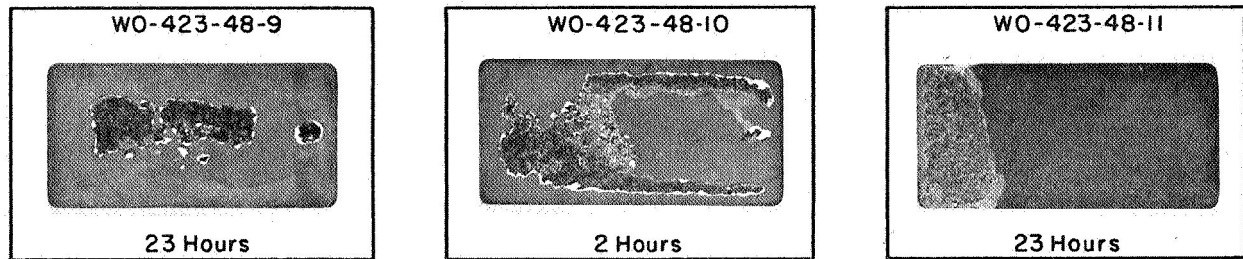


FIGURE 47

Mo-15.4Ti COATED T-222 SPECIMENS' SINTERED
AT 3630°F, SILICONIZED FOR 16 HOURS AND CYCLIC
OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

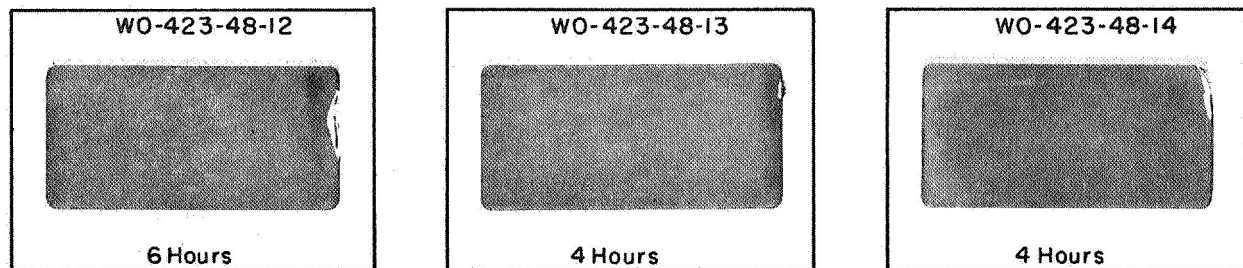


FIGURE 48

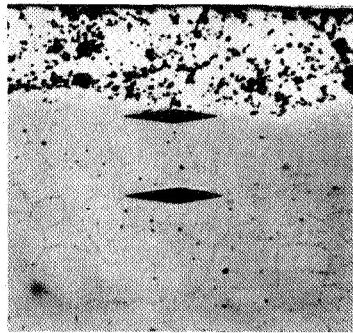
Mo-15.4Ti COATED T-222 SPECIMENS, SINTERED AT
2910°F, SILICONIZED FOR 16 HOURS AND CYCLIC
OXIDATION TESTED AT 1500°F AND 2400°F



Mo-15.4 Ti Coating

T-222 Substrate-309 kg/mm²
(50 gm Load)

Sintered at 2910°F 250x



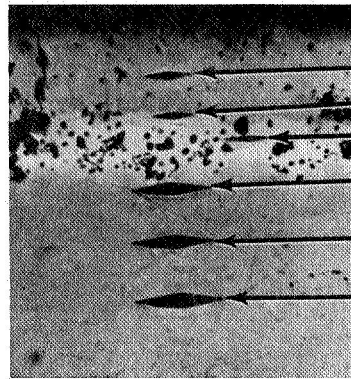
Mo-15.4 Ti Coating

T-222 Substrate-309 kg/mm²
(50 gm Load)

Sintered at 3630°F 250x

FIGURE 49

Mo-15.4Ti COATED T-222 SPECIMENS, SINTERED
AT 2910° F AND 3630° F UNDER REDUCED PRESSURE



Siliconized 2910°F 250x
Sintered Coating

Mo-Ti-Si Coating

907 kg/mm²
1235 kg/mm²
1138 kg/mm²
385 kg/mm²
322 kg/mm²
322 kg/mm²

(50 gm Load)



Siliconized 3630°F 250x
Sintered Coating

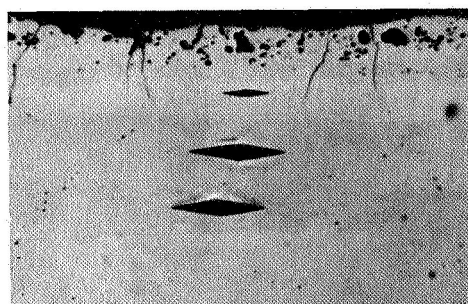
Mo-Ti-Si Coating

1235 kg/mm² (50 gm Load)

322 kg/mm² (50 gm Load)

FIGURE 50

Mo-15.4Ti COATED T-222 SPECIMENS SINTERED
AT 2910°F AND 3630°F, AND SILICONIZED FOR 16 HOURS
AT 2370°F UNDER REDUCED PRESSURE



Cr Si₂-20 VSi₂ Coating

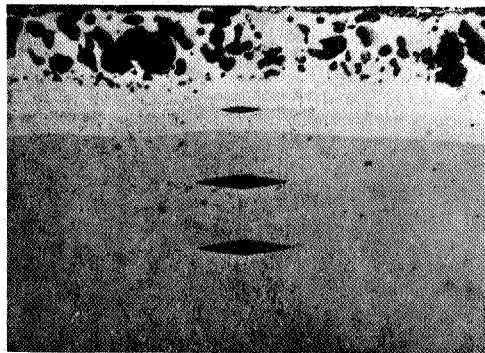
1138 kg/mm² (50gm Load)

T-222 Substrate 309 kg/mm²
(50gm Load)

250x

FIGURE 51

CrSi₂-20VSi₂ COATED T-222 SPECIMENS, SINTERED
AT 2910°F AND SILICONIZED AT 2370°F FOR 8 HOURS
UNDER REDUCED PRESSURE



MoSi₂-15CrSi₂-15VSi₂ Coating

Diffusion Zone - 1638 kg/mm²
(50gm Load)

T-222 Substrate - 336 kg/mm²
(50gm Load)

250x

FIGURE 52

MoSi₂-15CrSi₂-15VSi₂ COATED T-222 SPECIMENS, SINTERED
AT 2910°F AND SILICONIZED AT 2370°F FOR 8 HOURS
UNDER REDUCED PRESSURE

coating system were prepared and cyclic tested at 1500°F and 2400°F. The results for both coating systems are summarized in Figure 46. The results are also tabulated in Appendix A (pages A-48 and A-49). Photographs of the tested specimens are shown in Figures 53 and 54.

The oxidation performance of the CrSi₂-20VSi₂ was the better of the two; exhibiting oxidation lives of 46 - 466 hours at 1500°F and 46 - 100 hours at 2400°F, as compared to 46 - 156 hours at 1500°F and 48 - 86 hours at 2400°F for the ternary MoSi₂-15CrSi₂-15VSi₂ coating system. Although most of the specimens tested from these coating combinations did not satisfy the specified test duration of 400 hours at both test temperatures, they did show a pronounced improvement in reliability over coating systems tested previously.

3.3.6 Oxidation Tests of the Quaternary MoSi₂-WSi₂-TiSi₂-VSi₂

Coating System

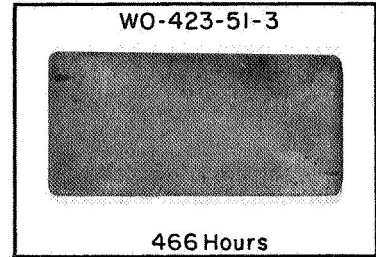
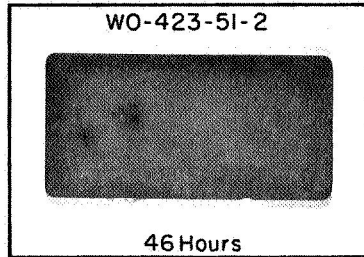
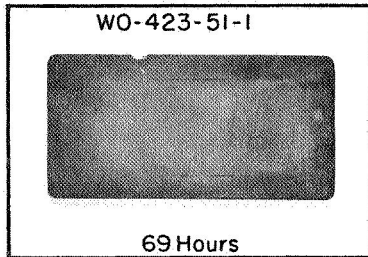
Two quaternary coating systems; namely, 35MoSi₂-35WSi₂-15TiSi₂-15VSi₂, and 33.6MoSi₂-27.6WSi₂-19.7TiSi₂-19.1VSi₂ were evaluated for tantalum alloy protection at 1500°F and 2400°F. The latter composition corresponded to Solar's⁽³⁾ TNV-7 coating composition after complete siliconization. Coatings of these systems were prepared as described in Section 3.2.2 and cyclic oxidation tested at 1500°F and 2400°F. The results are tabulated in Appendix A (pages A-50 and A-51) and also summarized in Figure 55. Photomicrographs depicting the coating structure of both coating systems are shown in Figure 56. Photographs of the tested specimens are shown in Figures 57 and 58. Both coating systems exhibited very poor oxidation behavior at both test temperatures. Oxidation lives of 52 hours or less were obtained. Failure occurred in all cases at the edge of the specimen. In some cases a surface type failure was also noted.

3.3.7 Oxidation Tests of MoSi₂-Base Coatings Over a VSi₂

Barrier Layer

In this task, a two-layer silicide coating system was examined which showed promise for protecting tantalum T-222 at 1500°F and 2400°F. This coating system consisted of a nominal 2.0 mil thick MoSi₂-30CrSi₂ outer coating applied over a nominal 1.0 mil thick VSi₂ inner coating on T-222. Each coating layer was deposited separately and sintered at 2910°F for 1 hour under argon. The VSi₂ coating was sintered without pressing, and the MoSi₂-30CrSi₂ coating was densified at 10 tsi prior to sintering. The dual coating system was then siliconized for 8 hours at 2370°F under reduced pressure and finally cyclic oxidation tested at 1500°F and 2400°F.

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

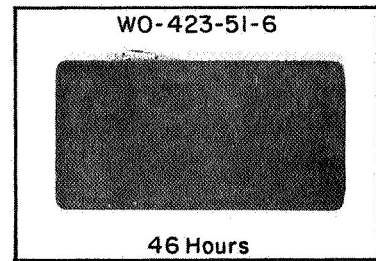
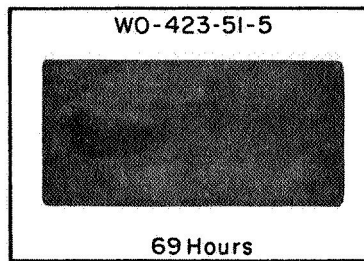
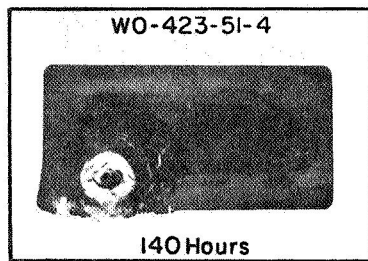
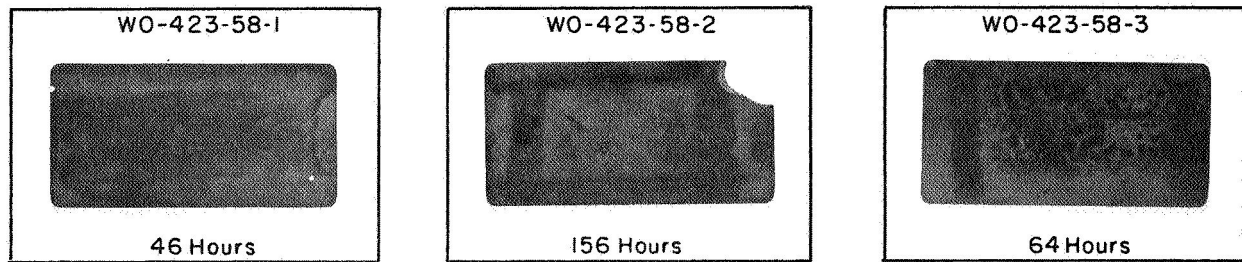


FIGURE 53

$\text{CrSi}_2\text{-20VSi}_2$ COATED T-222 SPECIMEN CYCLIC
OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

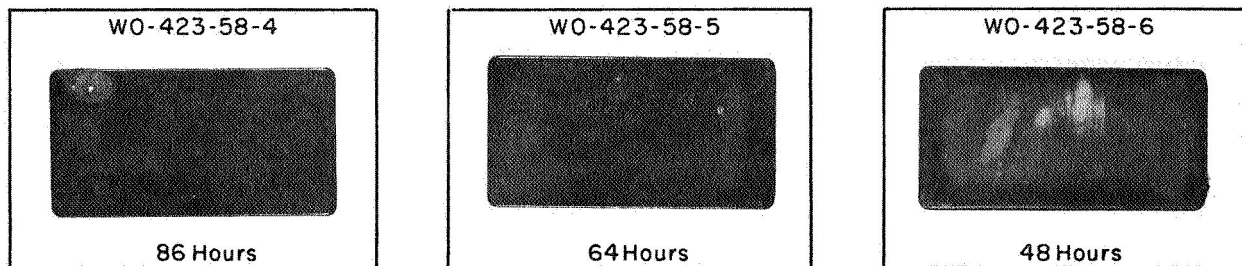


FIGURE 54

$\text{MoSi}_2\text{-15CrSi}_2\text{-15VSi}_2$ COATED T-222 SPECIMENS CYCLIC
OXIDATION TESTED AT 1500°F AND 2400°F

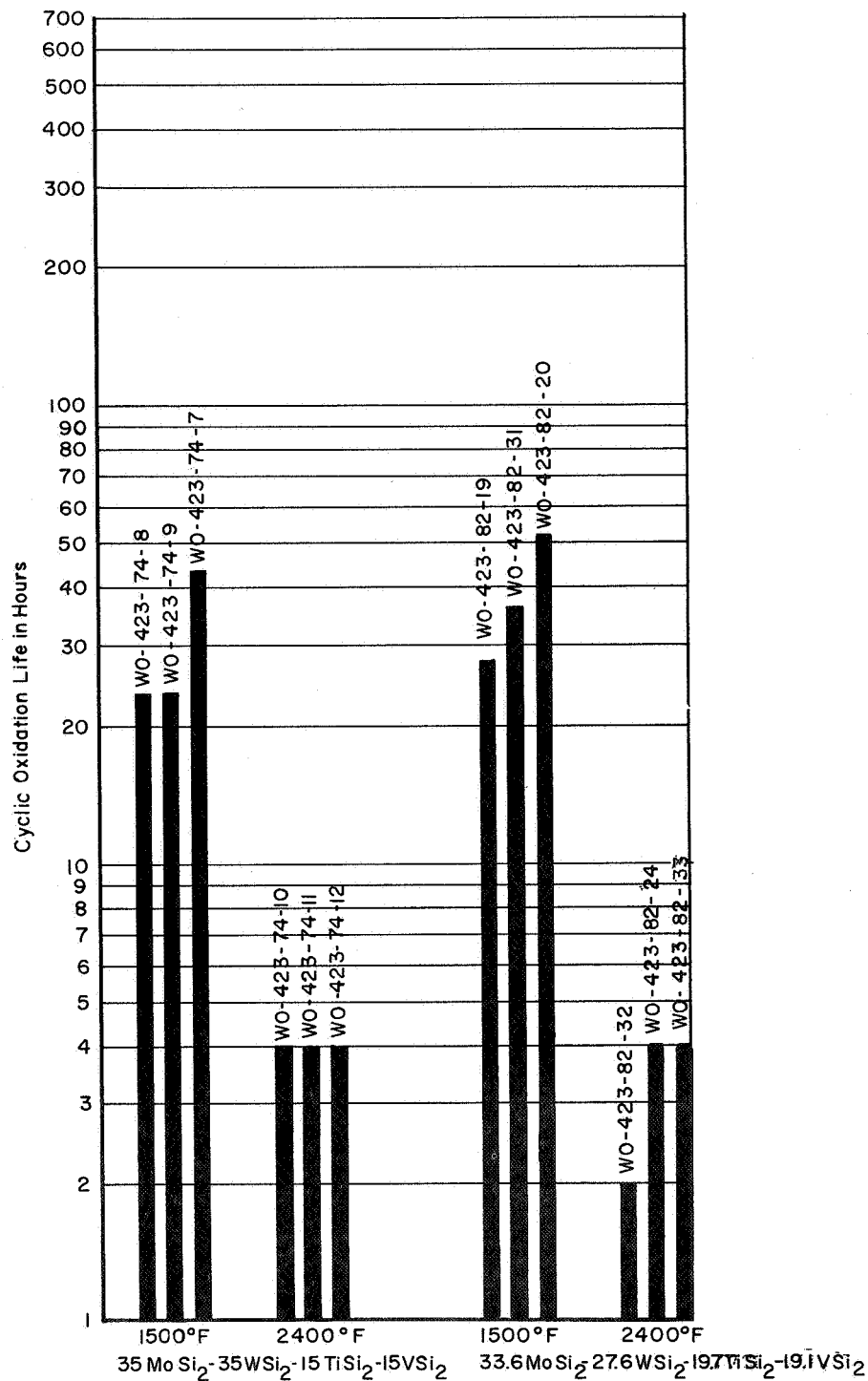
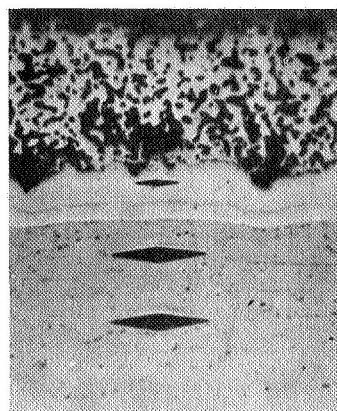


FIGURE 55

OXIDATION TEST RESULTS OF THE MoSi₂-WSi₂-TiSi₂-VSi₂
COATINGS ON T-222 AT 1500°F AND 2400°F
UNDER CYCLIC CONDITIONS

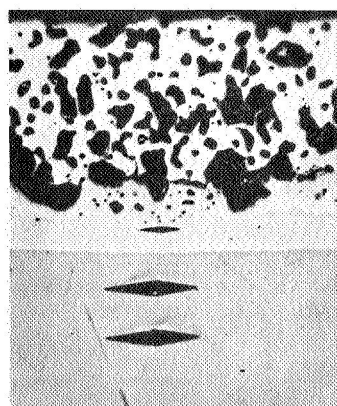


35 MoSi₂-35 WSi₂-15 TiSi₂-15 VSi₂ Coating

1215 kg/mm² (50gm Load)

T-222 Substrate-292 kg/mm² (50gm Load)

250x



33.6 MoSi₂-27.6 WSi₂-19.7 TiSi₂-19.1 VSi₂ Coating

Diffusion Zone - 1310 kg/mm² (50gm Load)

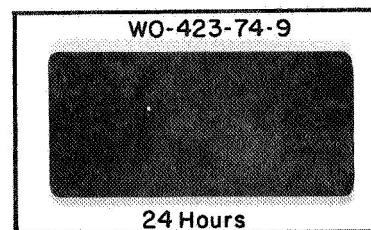
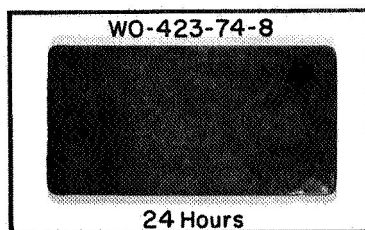
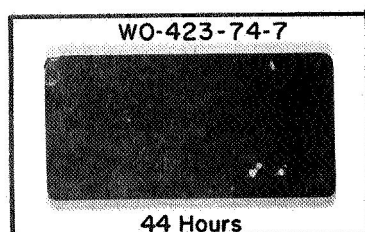
T-222 Substrate - 313 kg/mm² (50gm Load)

250x

FIGURE 56

SINTERED AND SILICONIZED MoSi₂-WSi₂-TiSi₂-VSi₂
COATED T-222 SPECIMEN

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

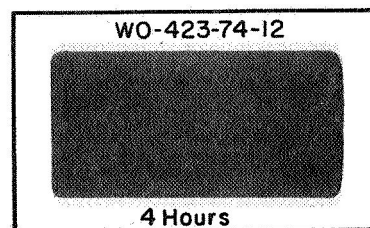
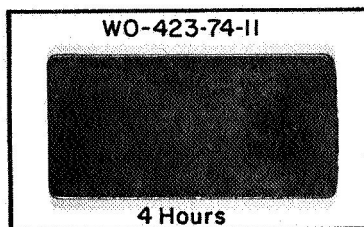
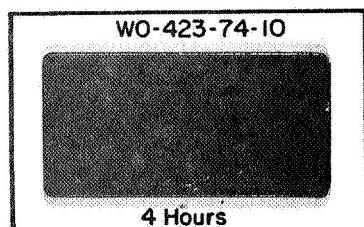
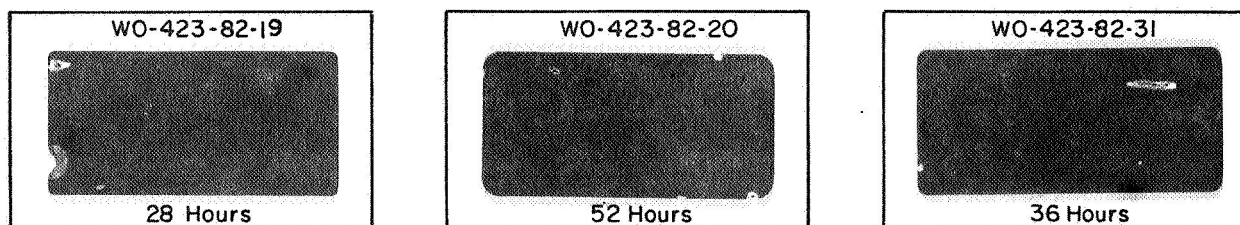


FIGURE 57

35 MoSi₂ - 35 WSi₂ - 15 TiSi₂ - 15 VSi₂ COATED T-222
SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F
AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

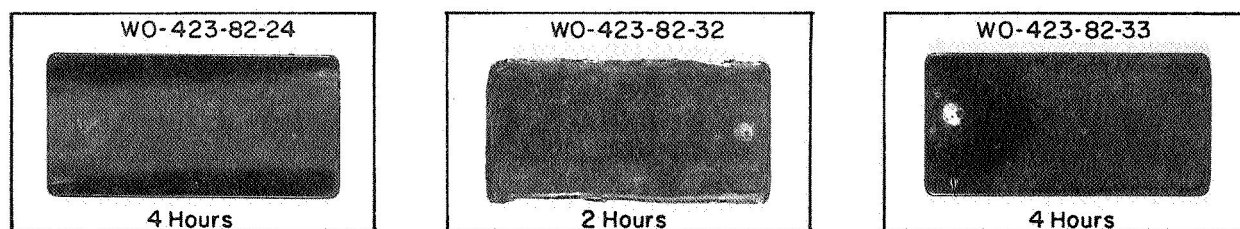


FIGURE 58

33.6 MoSi₂-27.6 WSi₂-19.7 TiSi₂-19.1 VSi₂ COATED T-222
SPECIMEN CYCLIC OXIDATION TESTED AT 1500°F
AND 2400°F

A photomicrograph depicting the coating structure of this coating combination is shown in Figure 59. The results of these cyclic oxidation tests are tabulated in Appendix A (page A-52) and summarized in Figure 60. Photographs of the tested specimens are shown in Figure 61.

As indicated in Figure 60, two specimens of this coating system passed the 400 hour cyclic test at 1500°F. The third specimen tested failed after 252 hours of testing at a site where the VSi₂ underlay coating was not patched.

At 2400°F, oxidation lives in the range of 90 - 138 hours were obtained. Failure occurred in the same location as in the 1500°F test.

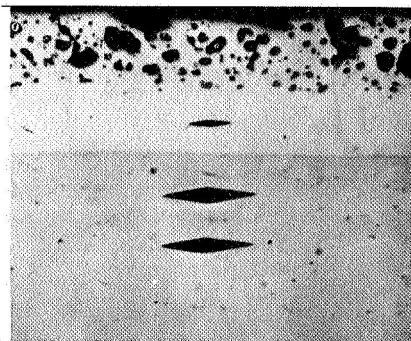
In view of these results, a duplicate set of specimens was prepared and oxidation tested. Special attention was given to the "patching" operation for each coating application. Also included in the 2400°F test were three additional MoSi₂-30CrSi₂/VSi₂ coated specimens that were given a 5 minute preoxidation treatment at 2910°F.

Results obtained on this set of specimens were very encouraging and are also shown in Figure 60 and tabulated in Appendix A (pages A-53 and A-54). Photographs of the tested specimens are shown in Figure 62.

At 1500°F, two of the three specimens tested survived 406 hours of testing without failure whereas the third specimen failed at a corner site after 244 hours of testing.

At 2400°F, one preoxidized specimen survived 366 hours of cyclic testing with failure occurring at the flat surface of the specimen. The remaining specimens (duplicate group and preoxidized group) failed prematurely after 48 - 244 hours of cyclic testing at either a patch, corner, edge, or surface site.

Although this coating system did not pass the 2400°F test, an improvement in oxidation behavior (more reliability and longer oxidation lives) was evident when compared to oxidation data obtained from the various coating systems tested previously. In view of this development, additional tests were designed and conducted on two additional coating combinations to determine the optimum relative layer thickness required to yield the desired oxidation resistance. For this study, a MoSi₂-20TiSi₂/VSi₂ and a MoSi₂-40CrSi₂/VSi₂ coating combination were selected.



Mo Si₂-30Cr Si₂ Coating

V Si₂ Coating-1235 kg/mm²
(50 gm Load)

T-222 Substrate-309 kg/mm²
(50 gm Load)

250x

FIGURE 59

MoSi₂-30CrSi₂/VSi₂ COATED T-222 SPECIMENS
SINTERED AT 2910°F AND SILICONIZED AT 2370°F
FOR 8 HOURS UNDER REDUCED PRESSURE

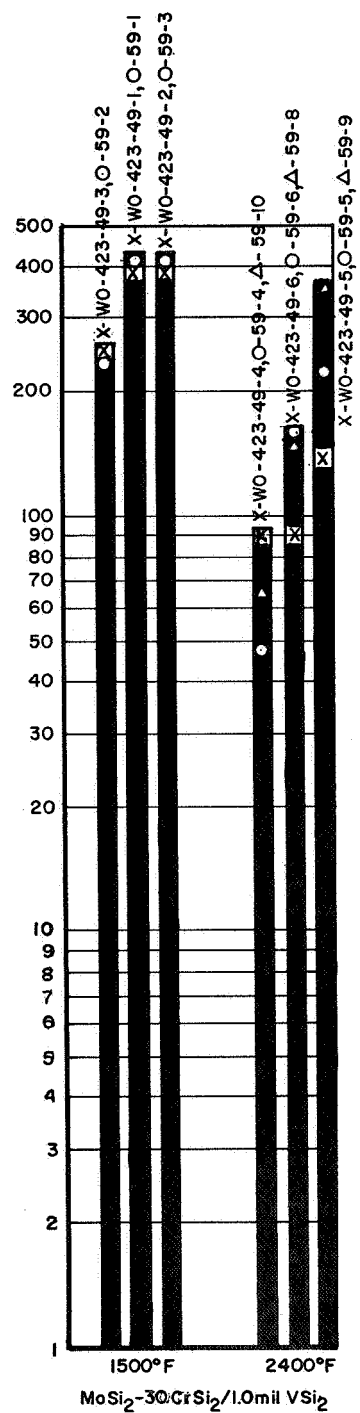
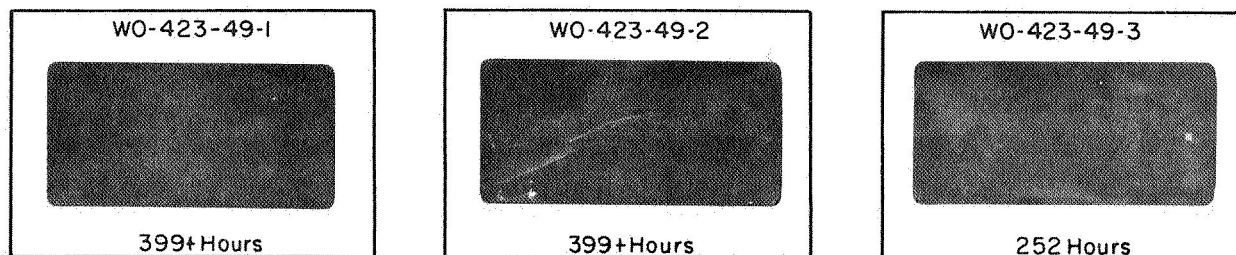


FIGURE 60

CYCLIC OXIDATION TEST RESULTS OF THE MoSi₂-30CrSi₂/
VSi₂ COATED T-222 SPECIMENS

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

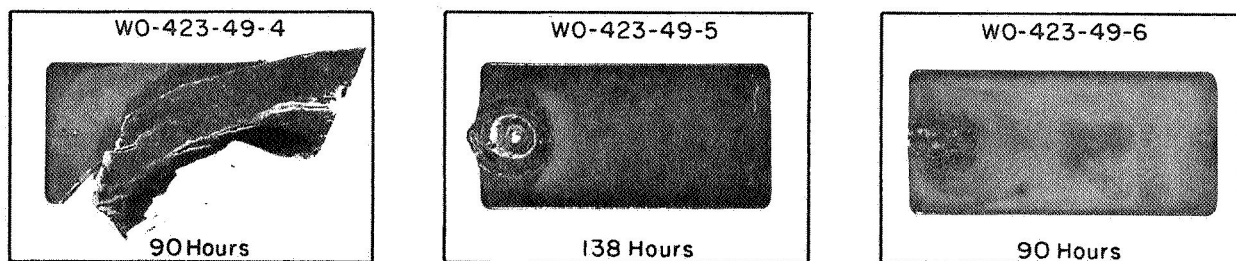
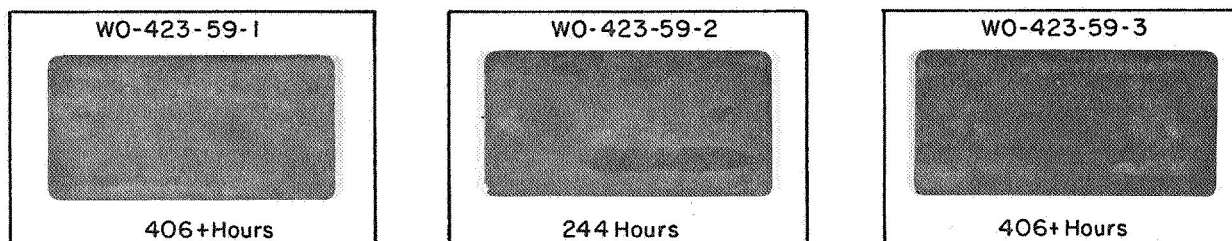


FIGURE 61

MoSi_2 -30CR Si_2 /V Si_2 COATED T-222 SPECIMENS
CYCLIC OXIDATION TESTED AT 1500°F AND 2400° F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

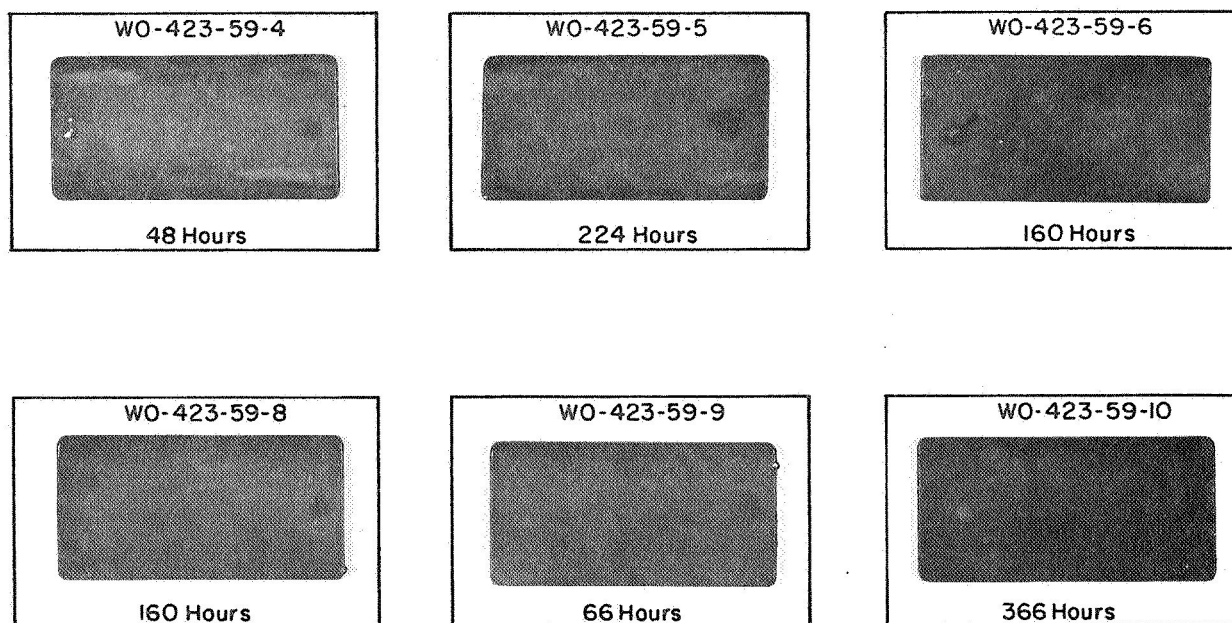


FIGURE 62

MoSi₂-30CrSi₂/VSi₂ COATED T-222 SPECIMENS
CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

A total of six (6) T-222 specimens (2 in x 1 in x 0.060 in) were coated with each of the following coatings and cyclic tested at 1500°F and 2400°F:

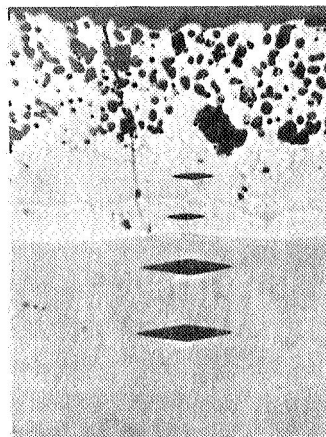
- a) 2.0 mil MoSi_2 -20 TiSi_2 /0.5 mil VSi_2
- b) 1.0 mil MoSi_2 -20 TiSi_2 /1.5 mil VSi_2
- c) 2.0 mil MoSi_2 -40 CrSi_2 /0.5 mil VSi_2
- d) 1.0 mil MoSi_2 -40 CrSi_2 /1.5 mil VSi_2

Photomicrographs depicting the coating structure of these two systems are shown in Figures 63 and 64. The oxidation test results obtained on these coating systems together with test results obtained previously on the 1.5 mil MoSi_2 -30 CrSi_2 /1.0 mil VSi_2 coating system are summarized in Figure 65 and tabulated in Appendix A (pages A-55 to A-58). Photographs of the tested specimens are shown in Figures 66 to 69.

Of the coatings tested, the MoSi_2 -20 TiSi_2 / VSi_2 (both thickness ratios) and the 1.0 mil MoSi_2 -40 CrSi_2 /1.5 mil VSi_2 coated T-222 specimens yielded the best oxidation test results at test temperatures of 1500°F and 2400°F. At 1500°F, two of the three specimens of the 2.0 mil MoSi_2 -20 TiSi_2 /0.5 mil VSi_2 coating system survived the 400 hour cyclic test. One specimen lasted 400 hours and the other 1350 hours (extended testing) without failing. The third specimen of this group of three exhibited an edge failure after 208 hours of testing. Comparable results were also obtained with the 1.0 mil MoSi_2 -20 TiSi_2 /1.5 mil VSi_2 coating system. In this case, one specimen accumulated 446 hours and one 1398 hours (extended testing) without failure, while the third specimen showed a corner failure after 258 hours of cyclic testing.

Exceptional 1500°F oxidation behavior was also noted for the MoSi_2 -40 CrSi_2 / VSi_2 coating system of both coating thickness ratios. Two specimens having a coating thickness ratio of 2.0/0.5 survived the 400 hour cyclic test while the third specimen of this group failed after 66 hours of testing. Specimens with the alternate coating thickness ratio of 1.0/1.5 showed two failures after 310 hours of testing, and one specimen survived the 400 hour test.

At 2400°F, the oxidation performance of the coating systems tested was comparable to those tested at 1500°F. Three of the 2.0 mil MoSi_2 -20 TiSi_2 /0.5 mil VSi_2 and two of the 1.0 mil MoSi_2 -20 TiSi_2 /1.5 mil VSi_2 coated specimens survived the 400 hour test. One specimen (1.0 mil MoSi_2 -20 TiSi_2 /1.5 mil VSi_2) failed at a corner after 258 hours of testing.



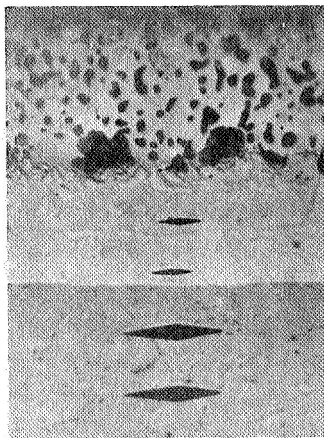
Mo Si₂-20 Ti Si₂ Coating

V Si₂ Coating-1265 kg/mm² (50gm Load)

Diffusion Zone-1510 kg/mm² (50gm Load)

T-222 Substrate-329 kg/mm² (50gm Load)

0.5 mil VSi₂ 250x
Barrier Coating



Mo Si₂-20 Ti Si₂ Coating

V Si₂ Coating-1310 kg/mm² (50gm Load)

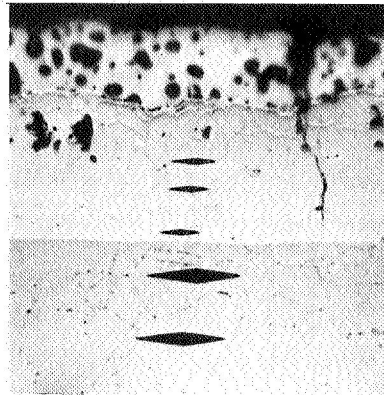
Diffusion Zone-1510 kg/mm² (50gm Load)

T-222 Substrate-292 kg/mm² (50gm Load)

1.5 mil VSi₂ 250x
Barrier Coating

FIGURE 63

SINTERED AND SILICONIZED MoSi₂ - 20 TiSi₂/VSi₂
COATED T-222 SPECIMEN



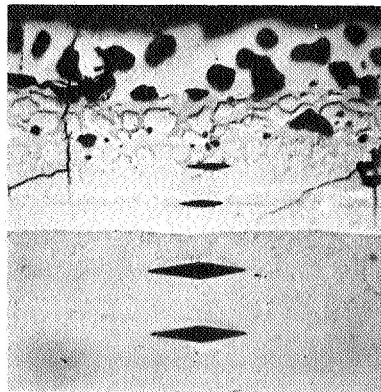
0.5mil VSi₂ 250x
Barrier Coating

Mo Si₂-40 Cr Si₂ Coating

V Si₂ Coating - 1310 kg/mm² (50 gm Load)

Diffusion Zone - 1405 kg/mm² (50 gm Load)

T-222 Substrate - 329 kg/mm² (50 gm Load)



1.5mil VSi₂ 250x
Barrier Coating

Mo Si₂-40 Cr Si₂ Coating

V Si₂ Coating - 1215 kg mm² (50 gm Load)

T-222 Substrate - 298 kg/mm² (50 gm Load)

FIGURE 64

SINTERED AND SILICONIZED MoSi₂-40CrSi₂/VSi₂
COATED T-222 SPECIMEN

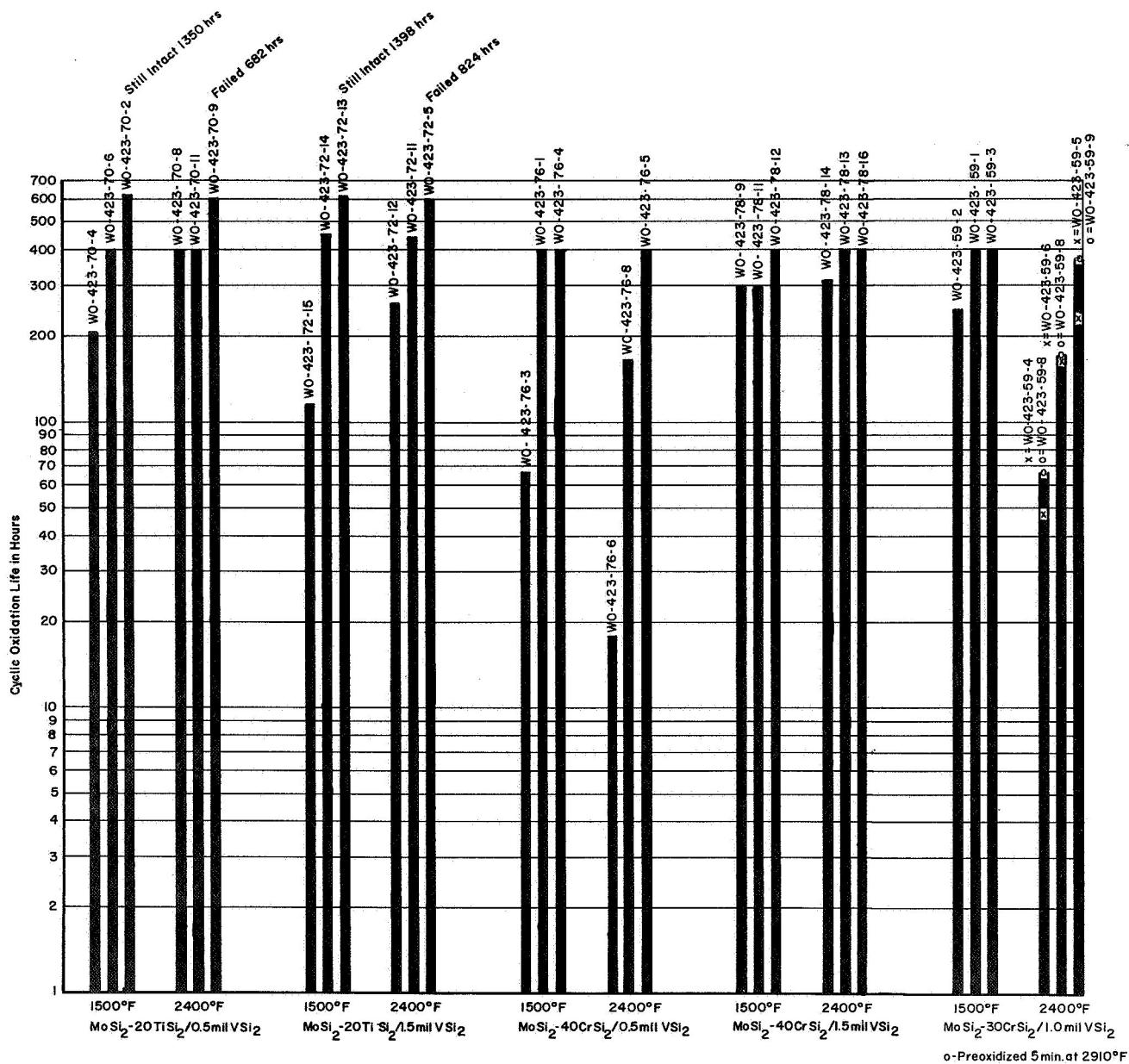
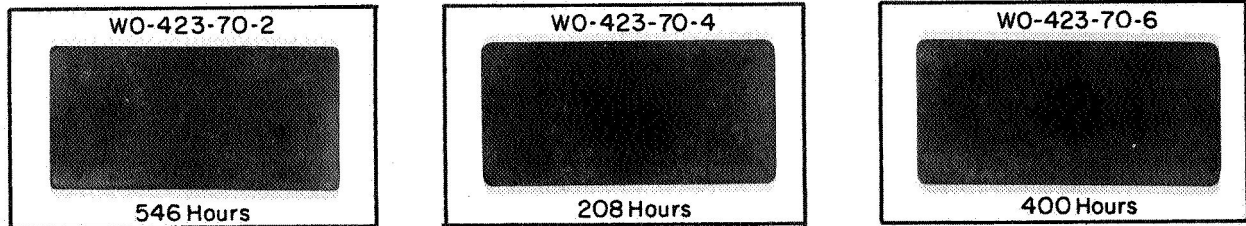


FIGURE 65

OXIDATION TEST RESULTS OF THE VARIOUS MoSi₂ BASE/
VSi₂ COATINGS ON T-222 AT 1500°F AND 2400°F
UNDER CYCLIC CONDITIONS

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

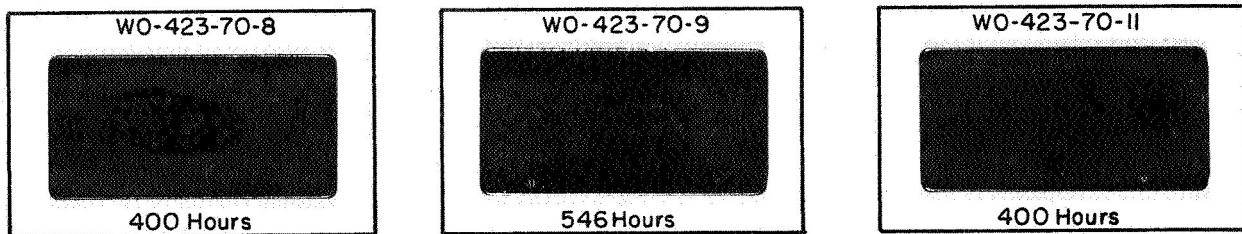
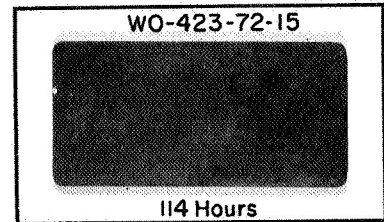
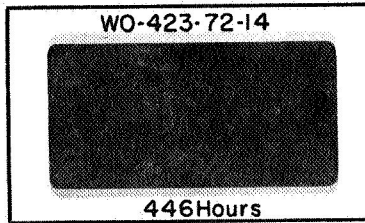
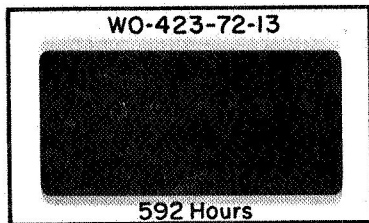


FIGURE 66

MoSi₂ - 20 TiSi₂/0.5 mil VSi₂ COATED T-222 SPECIMEN
CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

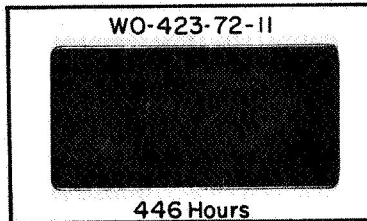
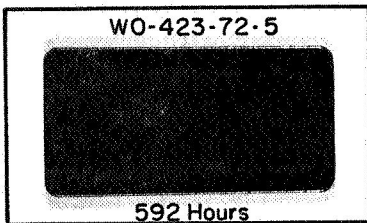
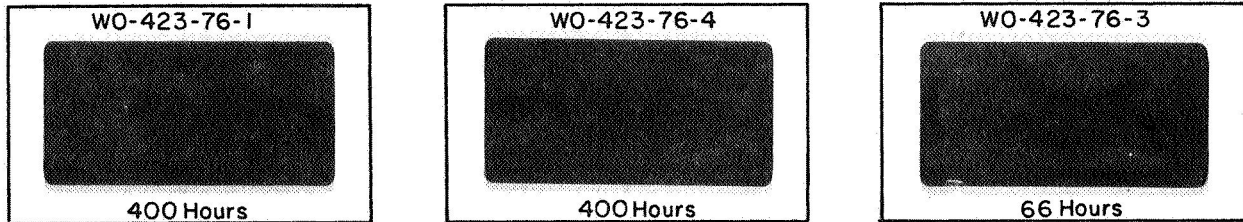


FIGURE 67

MoSi₂ - 20 TiSi₂/1.5 mil VSi₂ COATED T-222 SPECIMEN
CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

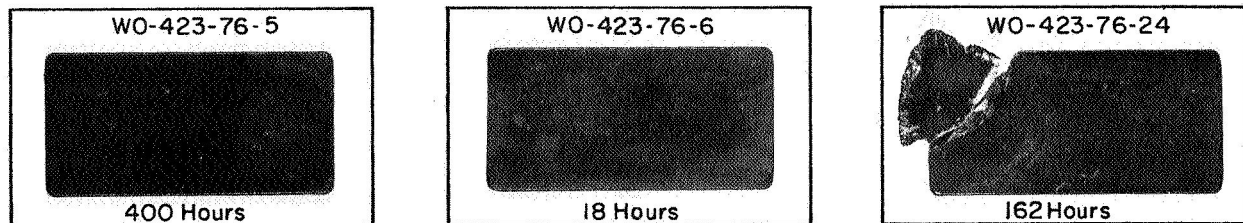
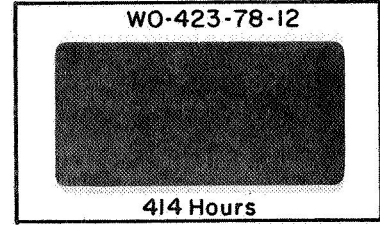
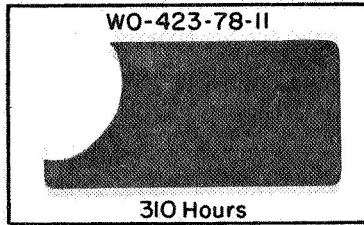
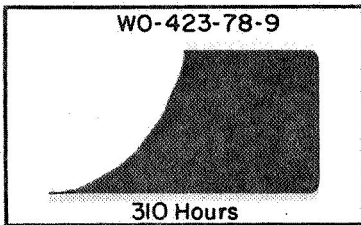


FIGURE 68

MoSi₂-40CrSi₂/0.5 mil VSi₂ COATED T-222 SPECIMEN
CYCLIC OXIDATION TESTED AT 1500°F AND 2400°F

1500°F OXIDIZED TEST SPECIMENS



2400°F OXIDIZED TEST SPECIMENS

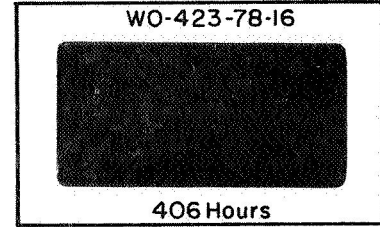
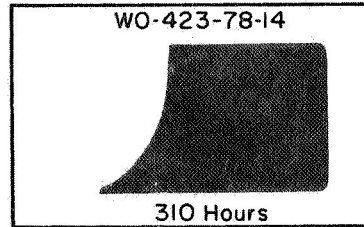
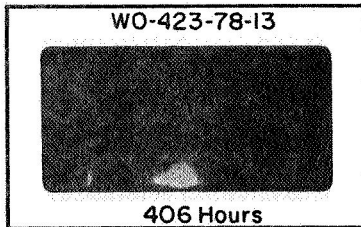


FIGURE 69

MoSi₂-40CrSi₂/1.5 mil VSi₂ COATED T-222 SPECIMEN
CYCLIC OXIDATION TESTED AT 1500°F AND 1400°F

In extended testing, one specimen of the 2.0 mil MoSi₂-20TiSi₂/0.5 mil VSi₂ and one of the 1.0 mil MoSi₂-20TiSi₂/1.5 mil VSi₂ accumulated 824 and 682 hours respectively before failing at a patched site.

The 1.0 mil MoSi₂-40CrSi₂/1.5 mil VSi₂ coating system also showed exceptional oxidation behavior at 2400°F. Two specimens passed the 400 hour test while the third specimen failed after 310 hours of testing. In the case of the 2.0 mil MoSi₂-40CrSi₂/0.5 mil VSi₂ coating system somewhat shorter oxidation lives (18, 160, and 400 hours) were obtained.

3.3.8 Bend Ductility Tests

Bend ductility tests (4t) were conducted at room temperature in air on MoSi₂-20TiSi₂/VSi₂ and the MoSi₂-40CrSi₂/VSi₂-coated T-222 specimens before and after oxidation using a Verson Press Brake. The brake was operated manually in order to control the rate of punch travel at approximately 1.0 inch per minute. All the specimens were bent to a 90° angle. Photographs of the bent specimens are shown in Figures 70 and 71.

Good ductility was shown by specimens of both coating composition before oxidation. However, after being exposed 400 hours at 2400°F in air, the substrate of both coating systems became embrittled indicating oxygen contamination as shown by the photomicrographs of Figures 72 and 73. Oxygen penetration into the T-222 substrate occurred at several sites, however, as indicated, no increase in substrate hardness (280 kg/mm²) was noted.

3.3.9 Reliability Tests of the MoSi₂-TiSi₂/VSi₂ and MoSi₂-CrSi₂/VSi₂ Coating Systems

One of the immediate objectives of this program was to improve the high and low temperature reliability of refractory silicide coatings. To test this objective, reliability tests were performed on the 2.0 mil MoSi₂-20TiSi₂/0.5 mil VSi₂ and the 1.0 mil MoSi₂-40CrSi₂/1.5 mil VSi₂ coating systems on the basis of the previous oxidation test results. Twenty specimens (10 at each test temperature) of the former and 10 specimens (5 at each test temperature) of the latter coating composition were prepared and tested at 1500°F and 2400°F.

In this series of tests the 1.0 mil MoSi₂-40CrSi₂/1.5 mil VSi₂ coating combination exhibited a marked improvement in coating reliability. Four of the five specimens tested at each temperature survived 626 hours of cyclic testing without failing. One specimen tested at 1500°F failed at an edge after 532 hours of testing while another exhibited a corner failure after 52 hours of testing at 2400°F.

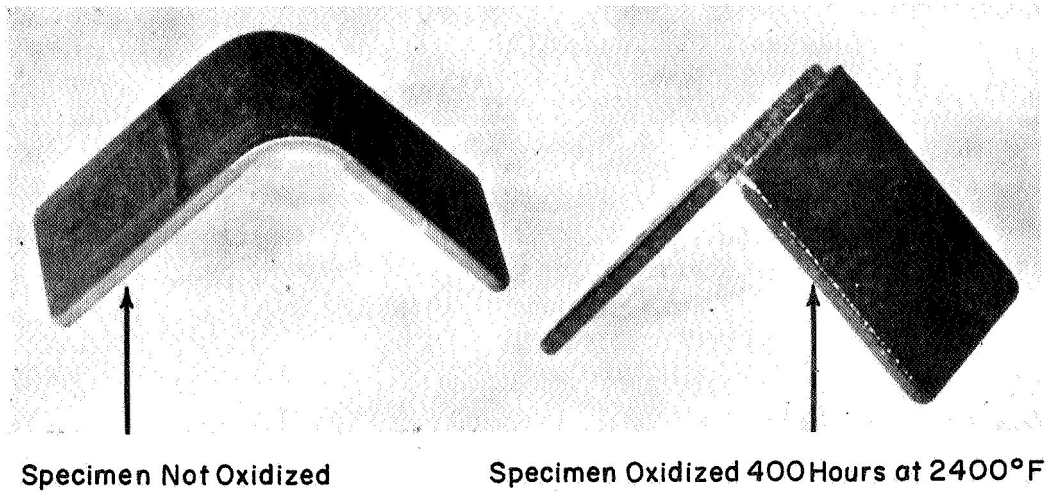


FIGURE 70

BEND TEST (4t) $\text{MoSi}_2\text{-40CrSi}_2/0.5 \text{ MIL VSi}_2$ COATED T-222
SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F

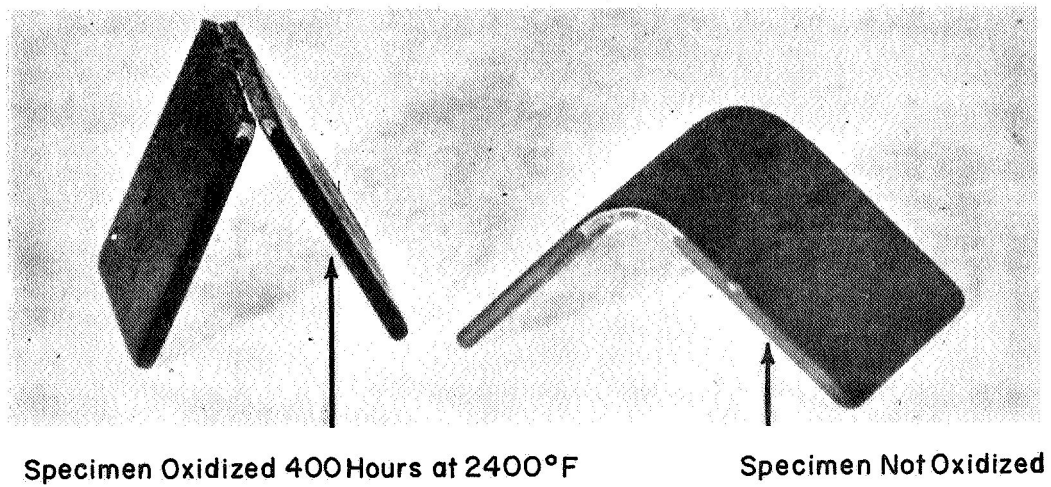
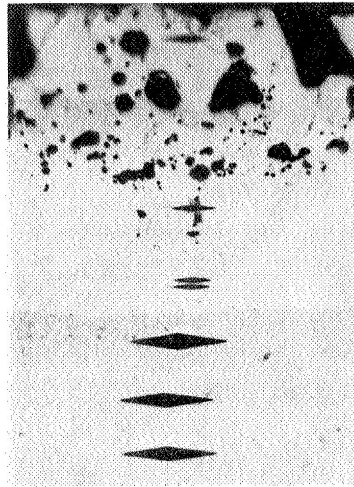


FIGURE 71

BEND TEST (4t) $\text{MoSi}_2\text{-20TiSi}_2/0.5 \text{ MIL VSi}_2$ COATED T-222
SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F



MoSi₂-40CrSi₂/VSi₂ Coating
1405 kg/mm² (50 gm Load)

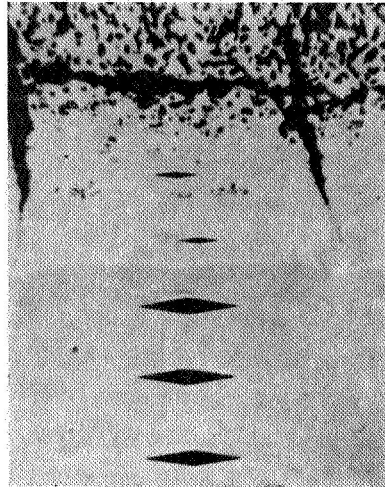
Diffusion Zone-1510 kg/mm²
(50 gm Load)

T-222 Substrate-259 kg/mm²
(50 gm Load)

250x

FIGURE 72

BEND TEST (4t) MoSi₂-40CrSi₂/0.5 MIL VSi₂ COATED T-222
SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F



MoSi₂-20TiSi₂/VSi₂ Coating
1310 kg/mm² (50 gm Load)

Diffusion Zone-1405 kg/mm²
(50 gm Load)

T-222 Substrate-280 kg/mm²
(50 gm Load)

250x

FIGURE 73

BEND TEST (4t) MoSi₂-20TiSi₂/0.5 MIL VSi₂ COATED T-222
SPECIMEN BEFORE AND AFTER OXIDATION AT 2400°F

In the case of the 2.0 mil MoSi₂-20TiSi₂/0.5 mil VSi₂ coating combination six out of ten specimens failed after 28 hours of testing at 1500°F. Of the four remaining specimens, one failed after 52 hours and two failed after 134 hours. Only one specimen remained intact after 626 hours of testing.

At 2400°F comparably poor results were obtained with the 2.0 mil MoSi₂-20TiSi₂/0.5 mil VSi₂ coatings. Six specimens failed after 28 hours, two after 32 hours, one after 52 hours and the remaining one after 534 hours of testing.

In view of this poor performance, a duplicate set of specimens was prepared and, in this case, each specimen was preoxidized at 2910°F for 3 minutes in order to initiate some glass (SiO₂) formation. This treatment, however, had an adverse effect on this coating combination. All ten specimens failed catastrophically after the second 2-hour cycle at 1500°F. Slightly improved results were obtained in tests of the preoxidized specimens at 2400°F, however, lifetimes were much poorer than those obtained in previous tests of this coating system (Section 3.3.7). The oxidation test results are tabulated in Appendix A (pages A-59 to A-68) and summarized in Figure 74.

At the time these tests were performed, no explanation could be found for the poor oxidation lives shown in the reliability tests compared to the excellent results obtained in initial tests of the MoSi₂-TiSi₂/VSi₂ system. A potential cause for suspicion was found in the fact that a new batch of prealloyed MoSi₂-20TiSi₂ powder had been prepared for the reliability tests. Later, however, it was found that siliconization of the specimens for the reliability tests had been accidentally carried out for 8 hours while the long-lived specimens described in Section 3.3.7 had been siliconized for 16 hours. Although this was undoubtedly the cause of premature failure in the reliability tests, time did not permit the preparation of another set of ten specimens for a new test.

3.3.10 Electron Microprobe Analysis

Electron microprobe analysis of five silicide coated T-222 alloy specimens was performed by E. F. Fullam, Inc. to determine the distribution of the coating and substrate elements before and after oxidation testing at 2400°F.

The coated specimens that were submitted for analysis were as follows:

<u>Specimen No.</u>	<u>Description</u>
WO-423-70-5	MoSi ₂ -20TiSi ₂ /VSi ₂ on T-222 before Oxidation testing

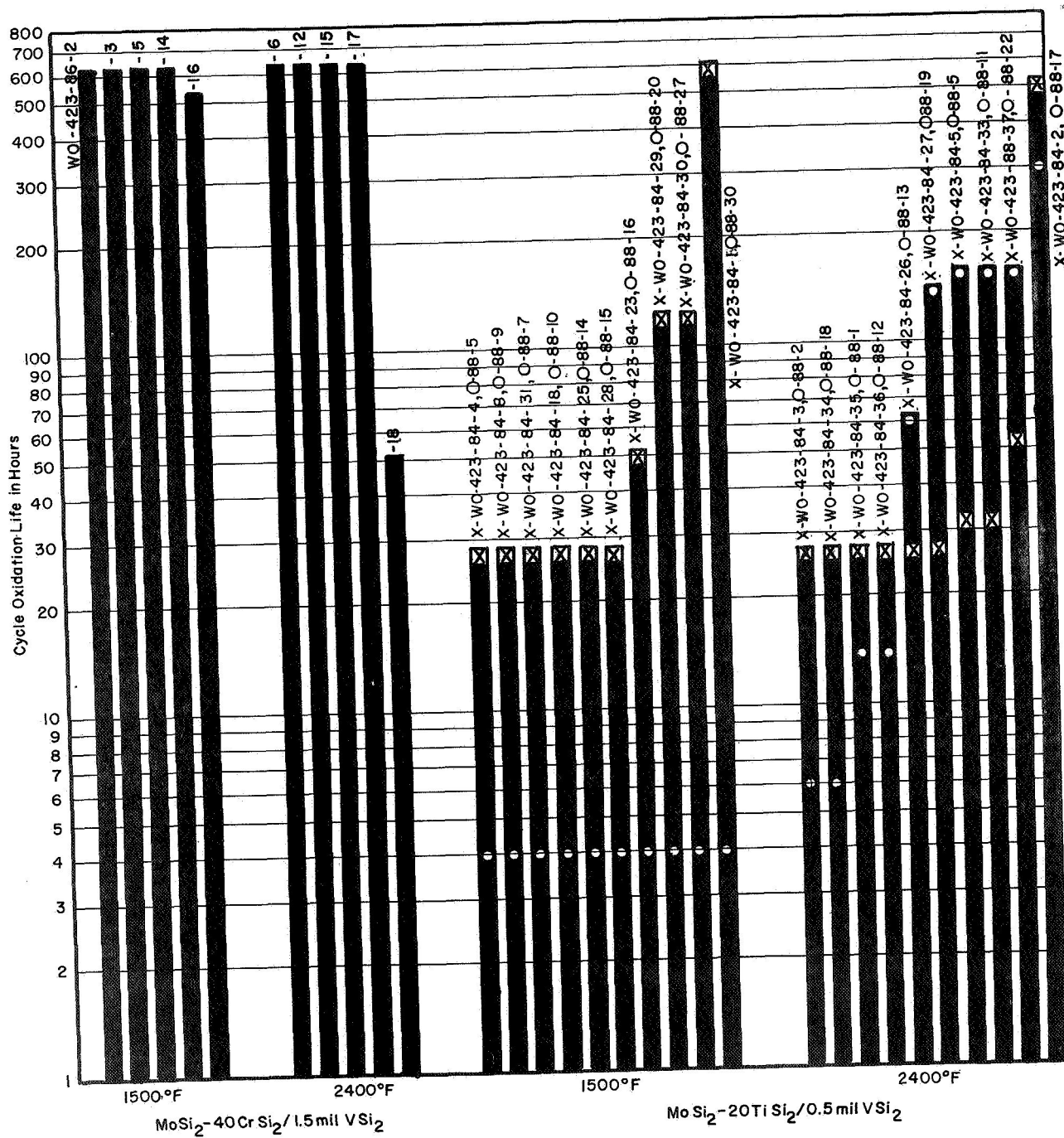


FIGURE 74

CYCLIC OXIDATION TEST RESULTS OF THE
MoSi₂-20TiSi₂/VSi₂ AND MoSi₂-40CrSi₂/VSi₂
COATING SYSTEMS AT 1500°F AND 2400°F

<u>Specimen No.</u>	<u>Description</u>
WO-423-76-11	MoSi ₂ -40CrSi ₂ /VSi ₂ on T-222 before oxidation testing
WO-423-82-15	33.6MoSi ₂ -27.6WSi ₂ -19.7TiSi ₂ -19.1VSi ₂ on T-222 before oxidation testing
WO-423-70-8	MoSi ₂ -20TiSi ₂ /VSi ₂ on T-222 after cyclic oxidation testing for 400 hours at 2400°F
WO-423-76-5	MoSi ₂ -40CrSi ₂ /VSi ₂ on T-222 after cyclic oxidation testing for 400 hours at 2400°F

The specimens were prepared for analysis by cutting small pieces from each, paying particular attention to retain the complete coating. The pieces were mounted in epoxy and polished in a manner to obtain a satisfactory surface without undercutting the coating any more than necessary. After polishing, the mounts were coated with an evaporated carbon film in order to make the plastic mount and the coating conductive. The areas examined were indexed with a scratched line to facilitate indexing of the specimen within the instrument as well as for future reference. An area for analysis was chosen on each side of the specimen.

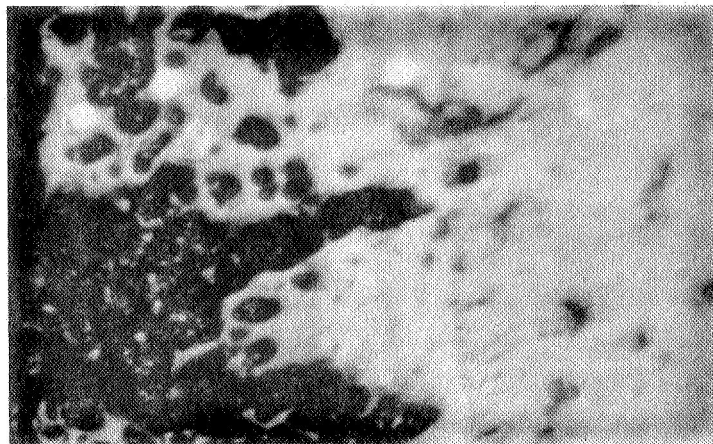
An accelerating potential of 25 kilovolts and .07 microamperes was used during the analyses. The analyzing crystal was ADP. The specimen was traversed under the beam in a direction normal to the analyzing crystal at a rate of 20 microns per minute.

In each case the traverse was started in the matrix and continued into the coating. The same track was used for each element. In order to establish the concentration level, the X-ray emission intensity of pure molybdenum, vanadium, titanium, chromium and silicon was measured. The elements tantalum and tungsten were not measured since the chemistry of the tantalum alloy was known.

X-ray scanning images were also made for each element of each specimen over the same area as the microprobe traverse. The X-ray scanning images, shown in Figures 77, 78, 81, 82, 85, 86, 89, 90, 93 and 94 consist of many dots which represent characteristic X-rays from a particular area. The lighter areas indicate higher element concentrations than the darker areas. These images show the general distribution of the elements and each area can be compared for the presence or absence of individual elements. To

Sample WO-423-70-5-R

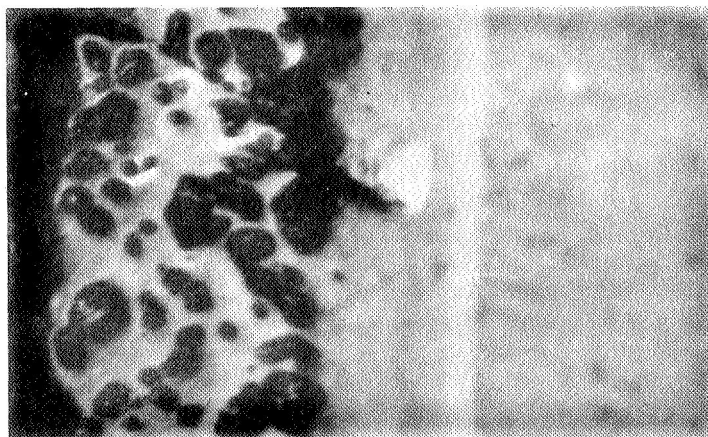
← Surface Coating → Unaffected T-222 Substrate



0 20 40 60 80 100 600x
Coating Thickness (microns)

Sample WO-423-70-5-L

← Surface Coating → Unaffected T-222 Substrate



0 20 40 60 80 100 600x
Coating Thickness (microns)

FIGURE 75

PHOTOMICROGRAPH OF $\text{MoSi}_2\text{-}20\text{TiSi}_2/\text{VSi}_2$ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-70-5)

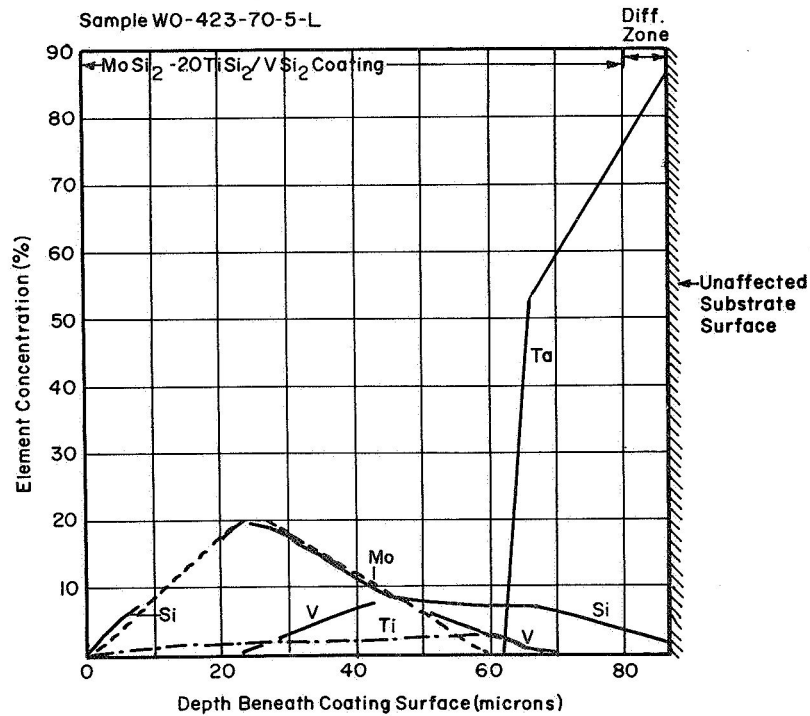
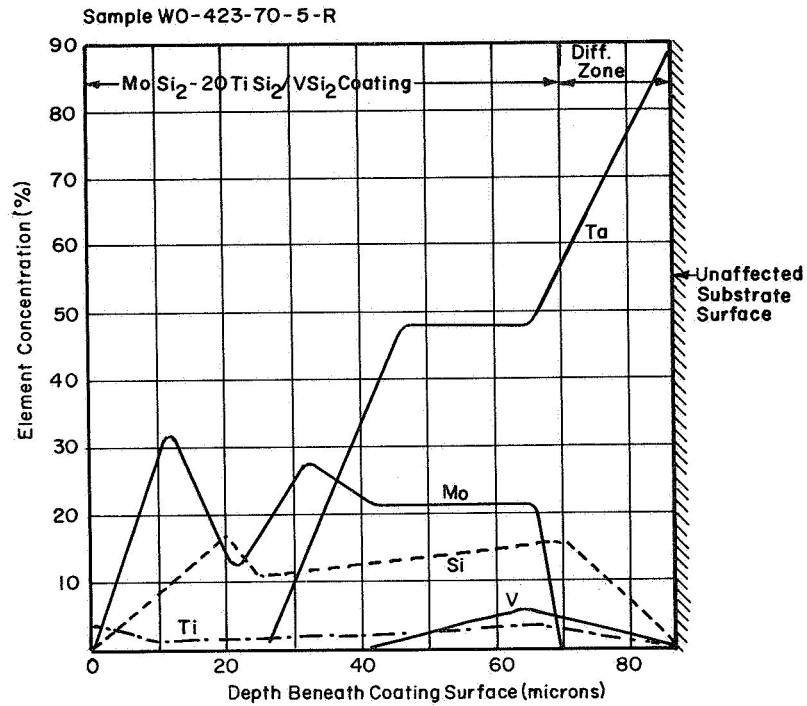
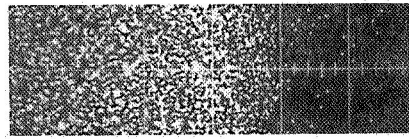


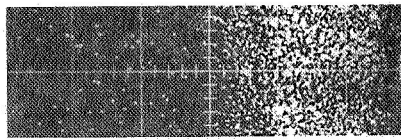
FIGURE 76

MICROPROBE ANALYSIS OF MoSi₂-20TiSi₂/VSi₂ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-70-5)

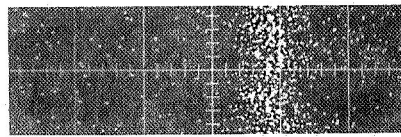
Sample WO-423-70-5-R



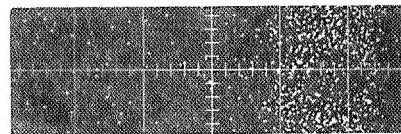
Ta



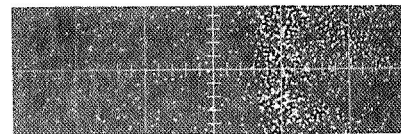
Si



V



Mo



Ti

200x

FIGURE 77

SCANNING X-RAY IMAGES OF $\text{MoSi}_2\text{-}20\text{TiSi}_2/\text{VSi}_2$ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-70-5-R)

Sample WO-423-70-5-L

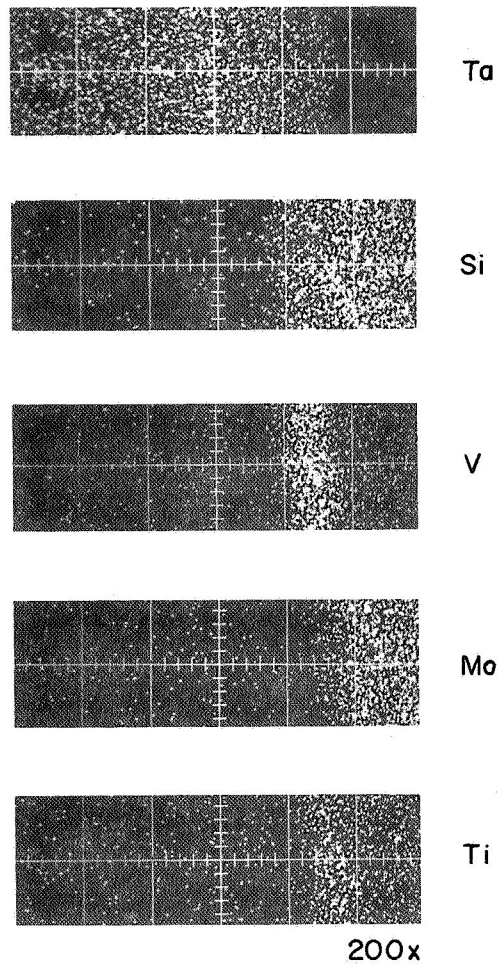


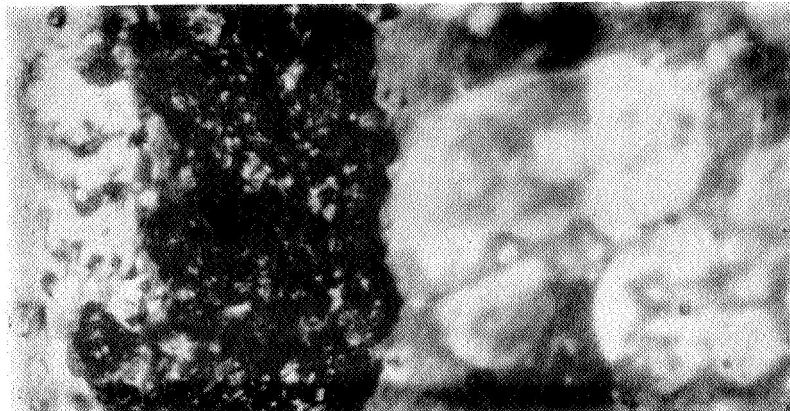
FIGURE 78

SCANNING X-RAY IMAGES OF $\text{MoSi}_2\text{-}20\text{TiSi}_2/\text{VSi}_2$ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-70-5-L)

Sample WO-423-70-8-R

← Surface Coating →

Unaffected T-222
Substrate



0 20 40 60 80 100 120 140 600x
Coating Thickness(microns)

Sample WO-423-70-8-L

← Surface Coating →

Unaffected T-222
Substrate



0 20 40 60 80 100 120 140 600x
Coating Thickness(microns)

FIGURE 79

PHOTOMICROGRAPH OF $\text{MoSi}_2\text{-}20\text{TiSi}_2/\text{VSi}_2$ ON T-222
AFTER 400 HOUR OXIDATION TEST AT 2400°F
(SPECIMEN WO-423-70-8)

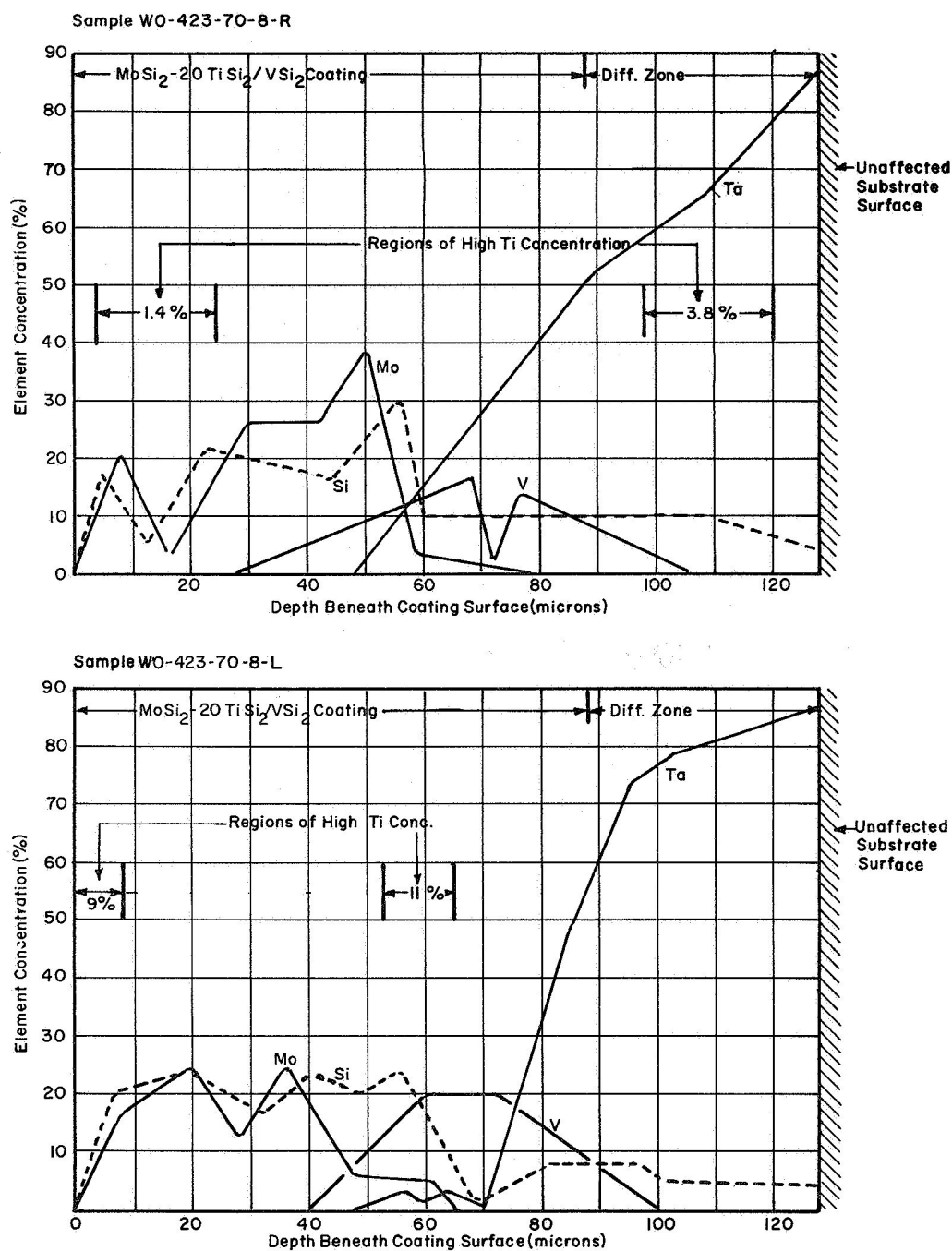
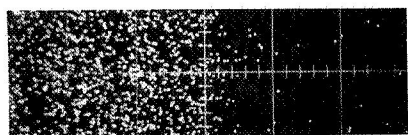


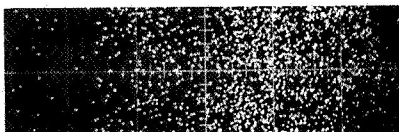
FIGURE 80

MICROPROBE ANALYSIS OF MoSi₂-20TiSi₂/VSi₂ ON T-222
AFTER 400 HOUR OXIDATION TEST AT 2400°F
(SPECIMEN WO-423-70-8)

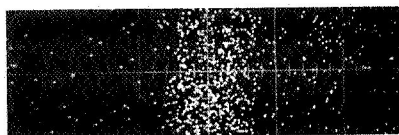
Sample WO-423-70-8-R



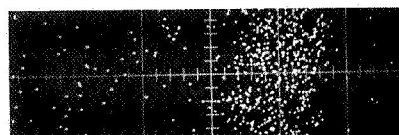
Ta



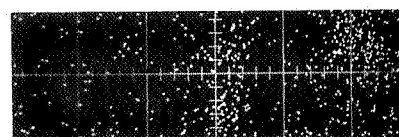
Si



V



Mo



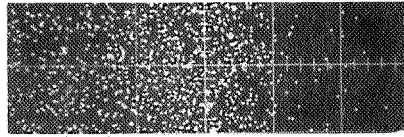
Ti

200 x

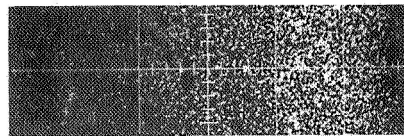
FIGURE 81

SCANNING X-RAY IMAGES OF MoSi_2 -20 TiSi_2 / VSi_2 ON T-222
AFTER 400 HOUR OXIDATION TEST AT 2400°F
(SPECIMEN WO-423-70-8-R)

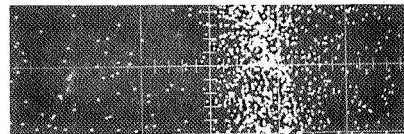
Sample WO-423-70-8-L



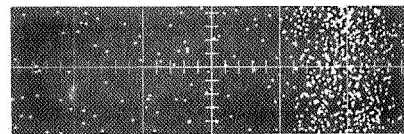
Ta



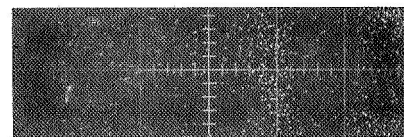
Si



V



Mo



Ti

200 x

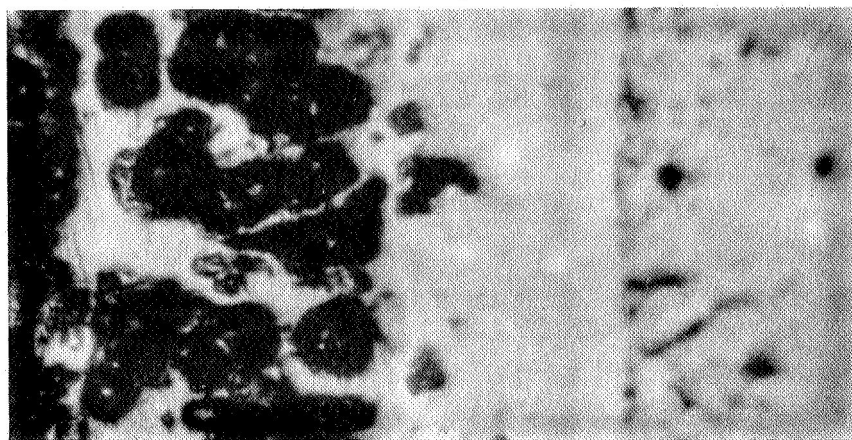
FIGURE 82

SCANNING X-RAY IMAGES OF MoSi_2 -20 TiSi_2 / VSi_2 ON T-222
AFTER 400 HOUR OXIDATION TEST AT 2400°F
(SPECIMEN WO-423-70-8-L)

Sample WO-423-76-11-R

← Surface Coating →

Unaffected T-222
Substrate

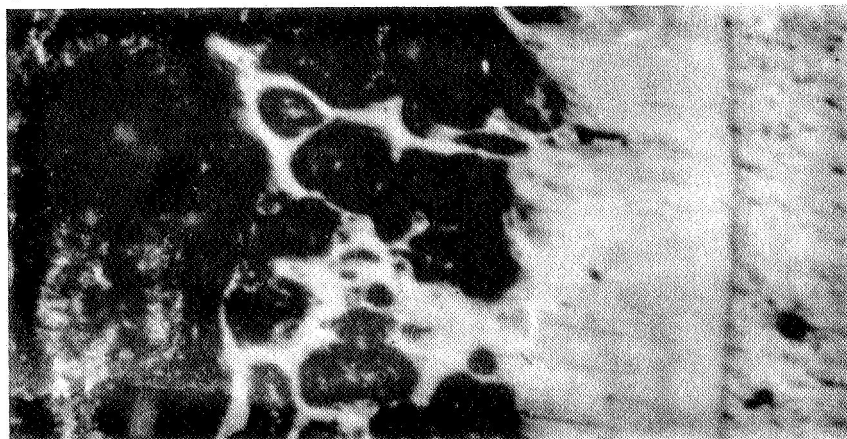


0 20 40 60 80 100 120 600x
Coating Thickness(microns)

Sample WO-423-76-11-L

← Surface Coating →

Unaffected T-222
Substrate



0 20 40 60 80 100 120 140 160 600x
Coating Thickness(microns)

FIGURE 83

PHOTOMICROGRAPH OF $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-76-11)

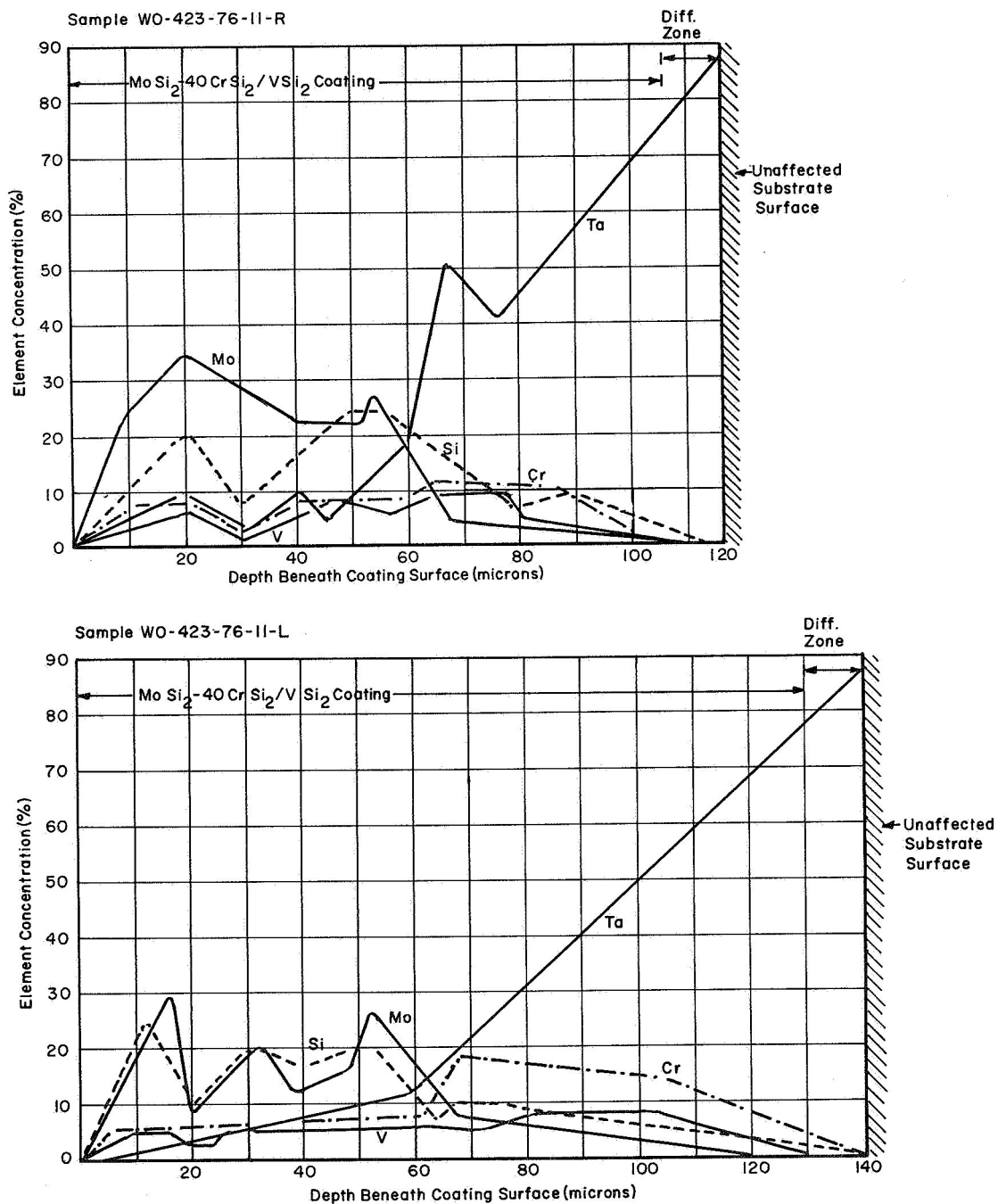
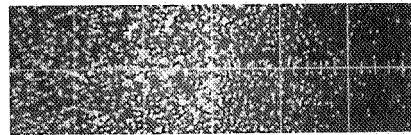


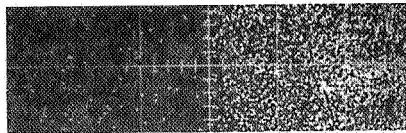
FIGURE 84

MICROPROBE ANALYSIS OF MoSi₂-40CrSi₂/VSi₂ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-76-11)

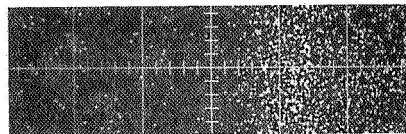
Sample WO-423-76-II-R



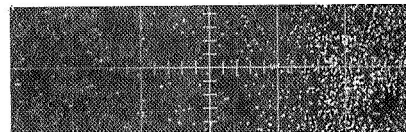
Ta



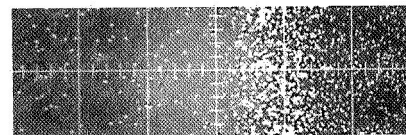
Si



V



Mo



Cr

200x

FIGURE 85

SCANNING X-RAY IMAGES OF $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-76-11-R)

Sample WO-423-76-11-L

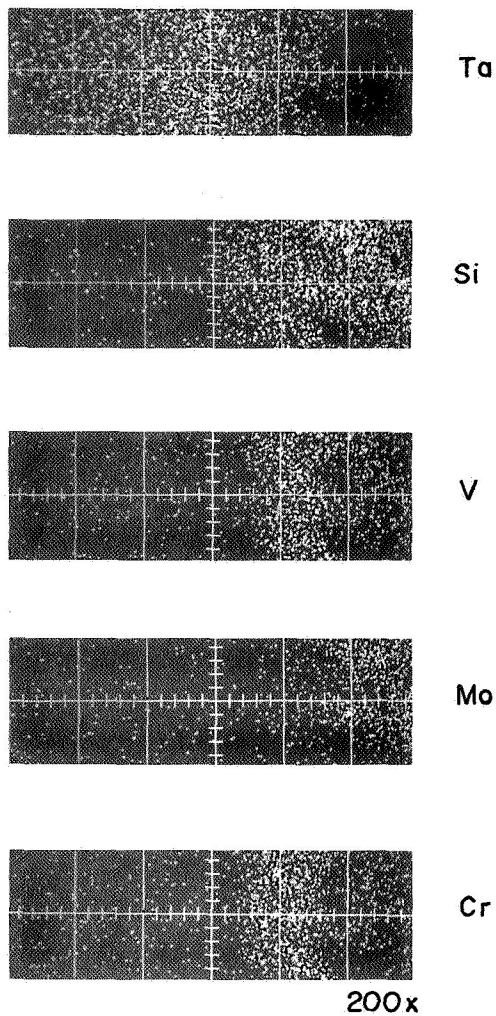


FIGURE 86

SCANNING X-RAY IMAGES OF $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ ON T-222
BEFORE OXIDATION
(SPECIMEN WO-423-76-11-L)

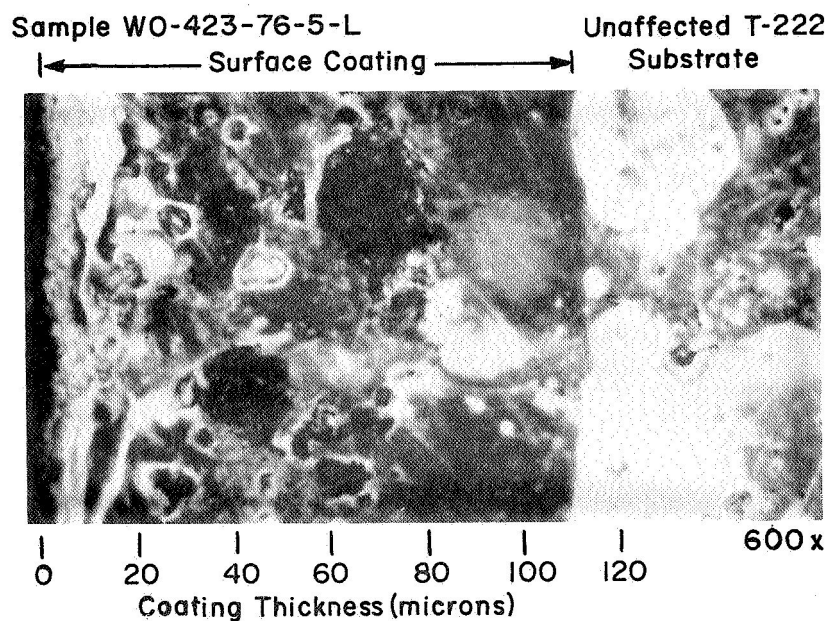
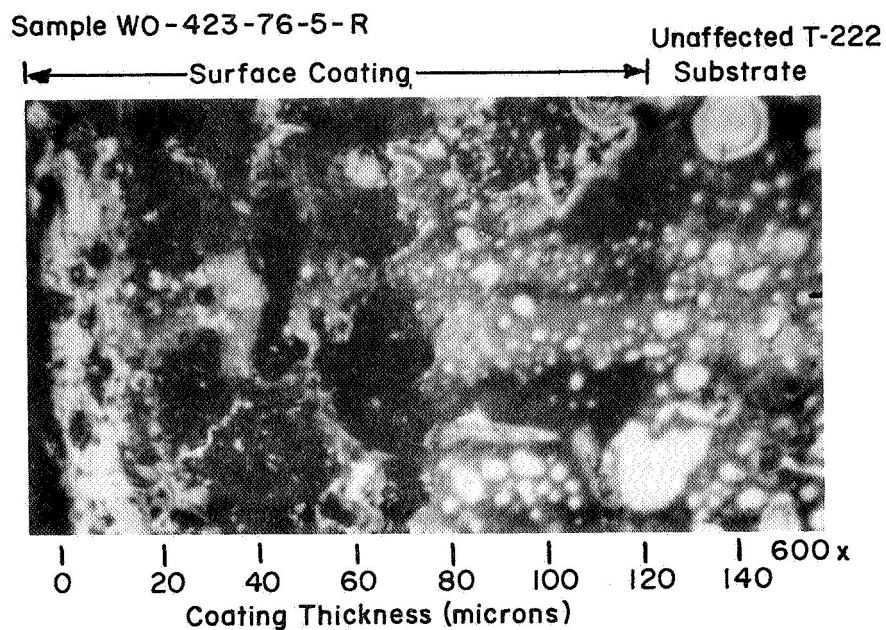


FIGURE 87

PHOTOMICROGRAPH OF $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ ON T-222
 AFTER 400 HOUR OXIDATION TEST AT 2400°F
 (SPECIMEN WO-423-76-5)

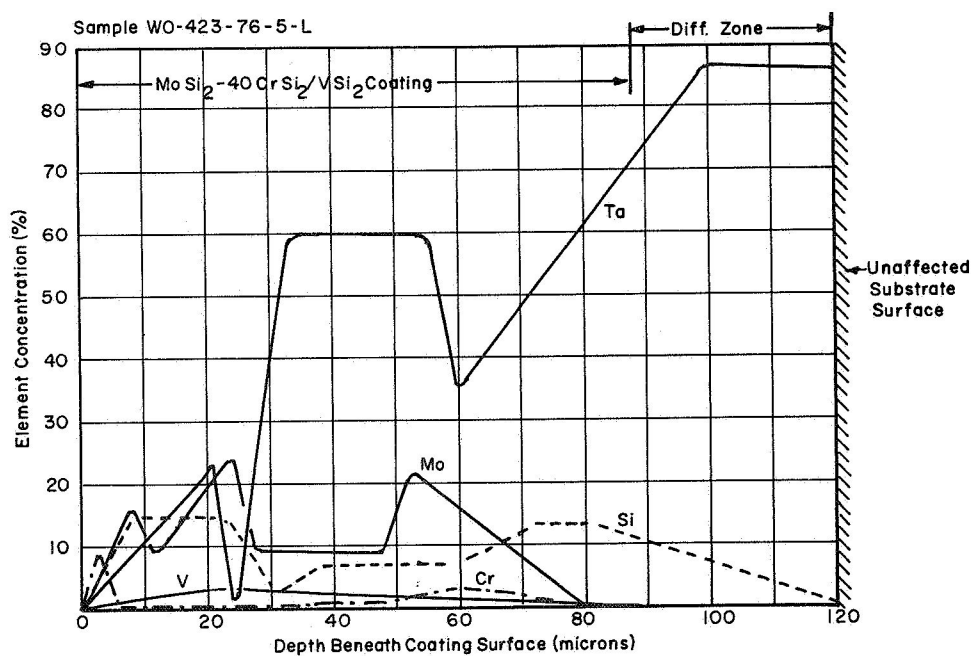
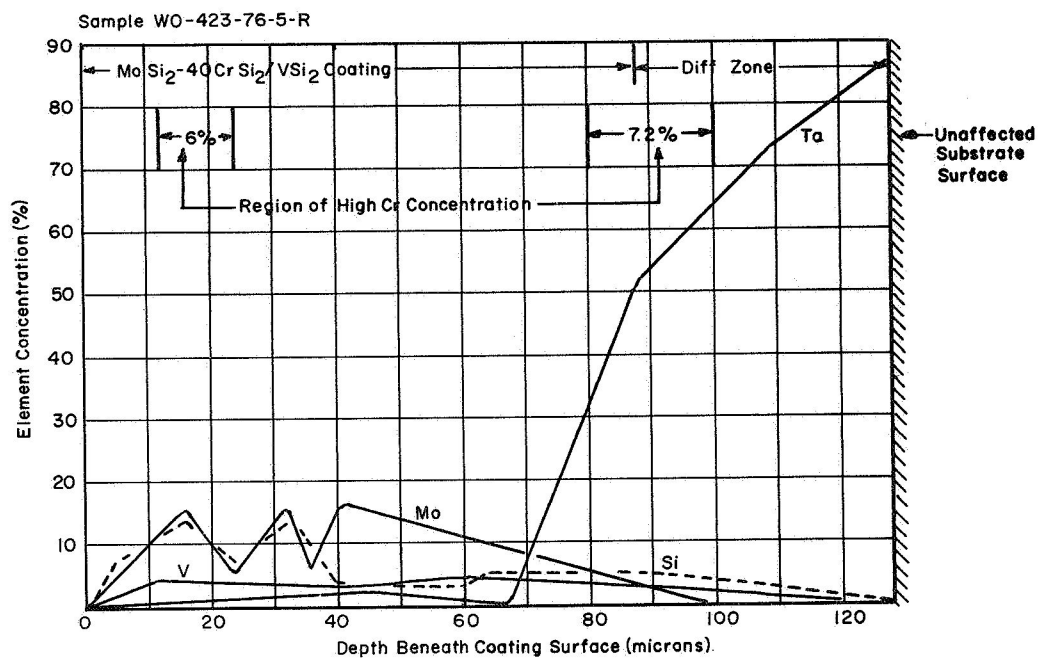


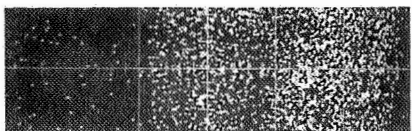
FIGURE 88

MICROPROBE ANALYSIS OF MoSi₂-40CrSi₂/VSi₂ ON T-222
AFTER 400 HOUR OXIDATION TEST AT 2400°F
(SPECIMEN WO-423-76-5)

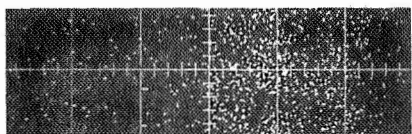
Sample WO-423-76-5-R



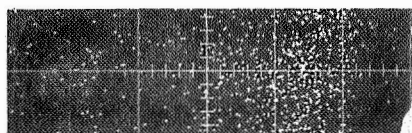
Ta



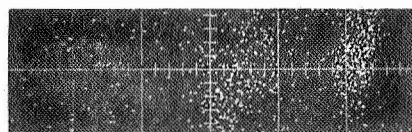
Si



V



Mo



Cr

200x

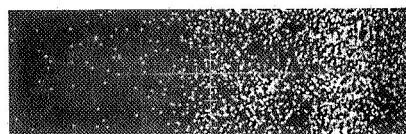
FIGURE 89

SCANNING X-RAY IMAGES OF $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ ON T-222
AFTER 400 HOUR OXIDATION TEST AT 2400°F
(SPECIMEN WO-423-76-5-R)

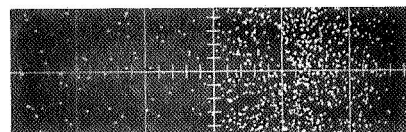
Sample WO-423-76-5-L



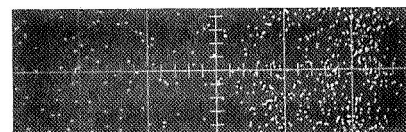
Ta



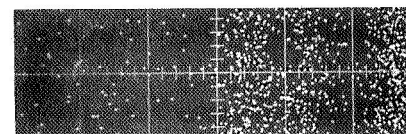
Si



V



Mo



Cr

200x

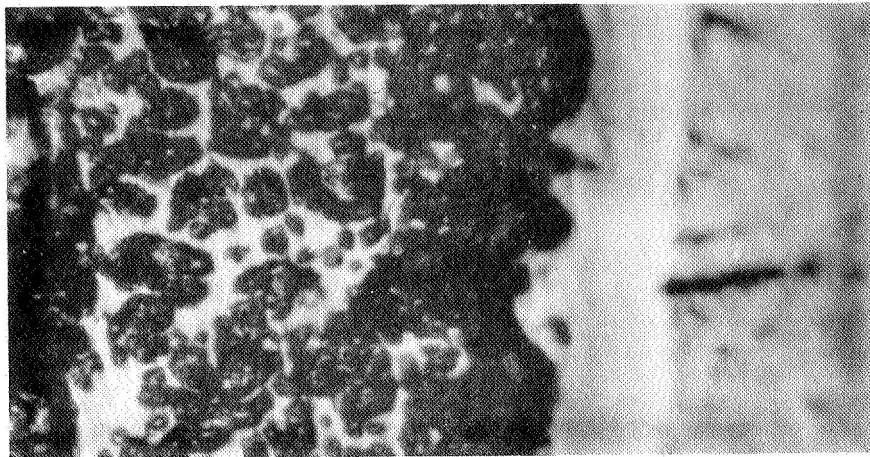
FIGURE 90

SCANNING X-RAY IMAGES OF $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ ON T-222
AFTER 400 HOUR OXIDATION TEST AT 2400°F
(SPECIMEN WO-423-76-5-L)

Sample WO-423-82-15-R

Unaffected T-222

← Surface Coating → | Substrate

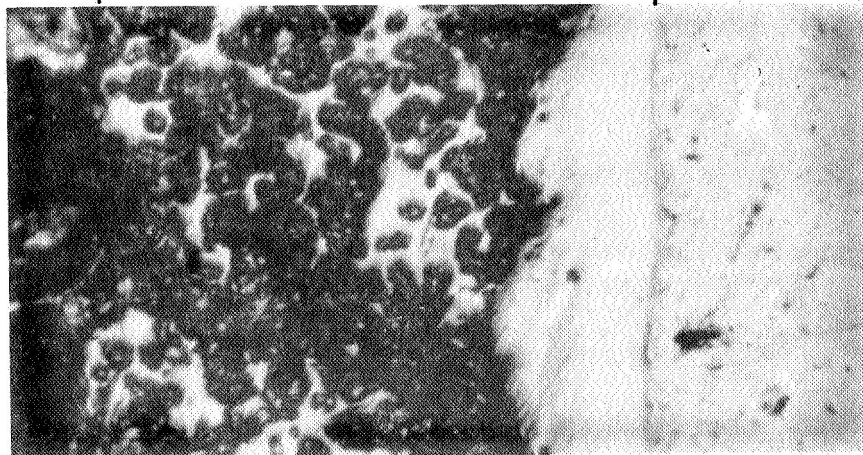


0 20 40 60 80 100 120 140 600x
Coating Thickness (microns)

Sample WO-423-82-15-L

Unaffected T-222

← Surface Coating → | Substrate



0 20 40 60 80 100 120 140 600x
Coating Thickness (microns)

FIGURE 91

PHOTOMICROGRAPH OF 33.6MoSi_2 - 27.6WSi_2 - 19.7TiSi_2 - 19.1VSi_2 ON T-222
(SPECIMEN WO-423-82-15 NOT OXIDIZED)

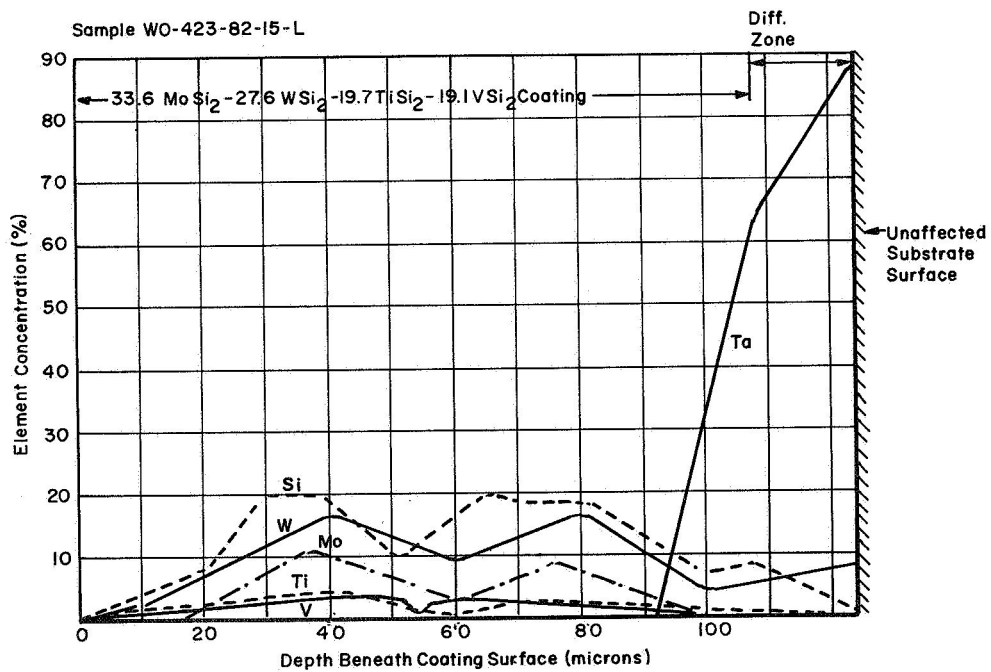
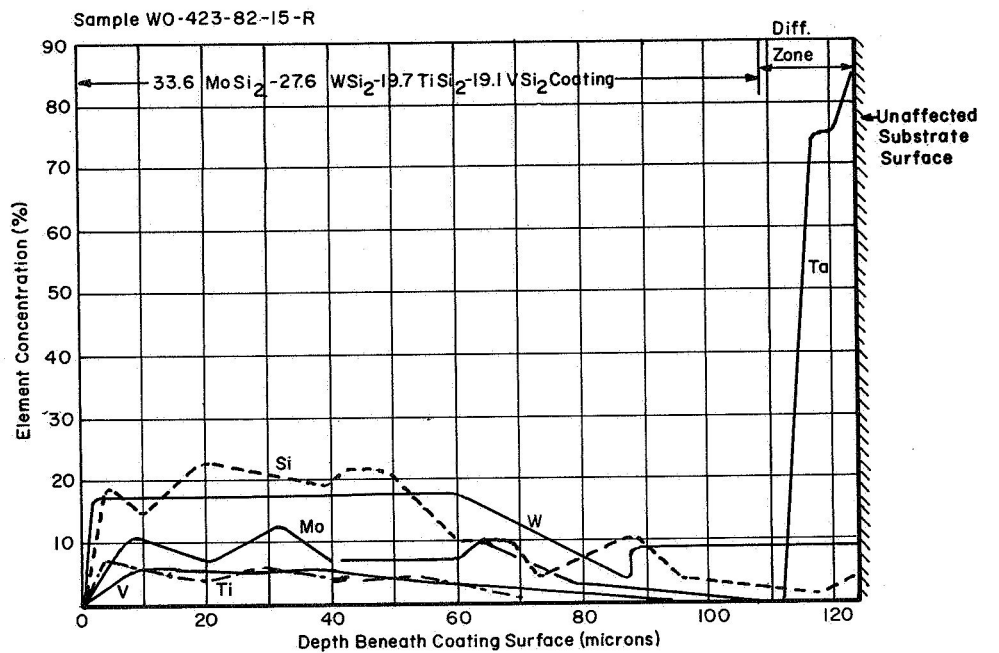
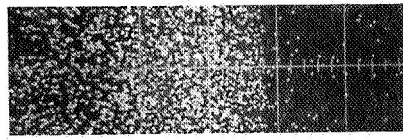


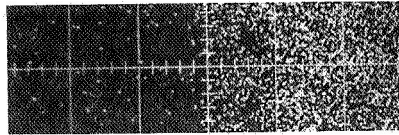
FIGURE 92

MICROPROBE ANALYSIS OF 33.6MoSi₂-27.6WSi₂-19.7TiSi₂-
19.1VSi₂ ON T-222
(SPECIMEN WO-423-82-15 NOT OXIDIZED)

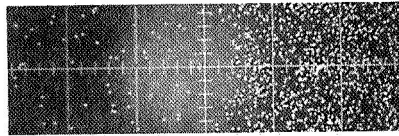
Sample WO-423-82-15-R



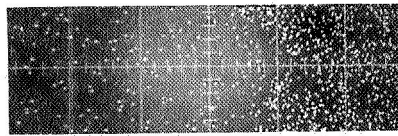
Ta



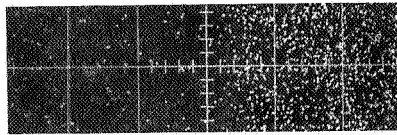
Si



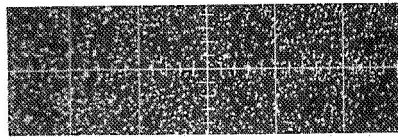
V



Mo



Ti



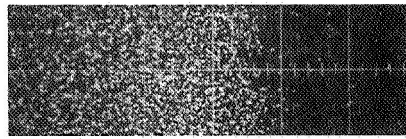
W

200 x

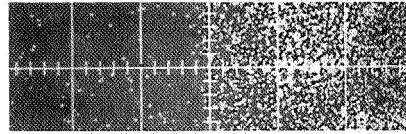
FIGURE 93

SCANNING X-RAY IMAGES OF 33.6MoSi_2 - 27.6WSi_2 - 19.7TiSi_2 -
 19.1VSi_2 ON T-222
(SPECIMEN WO-423-82-15-R NOT OXIDIZED)

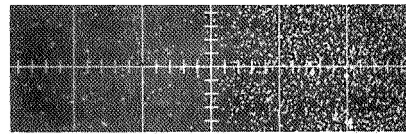
Sample WO-423-82-15-L



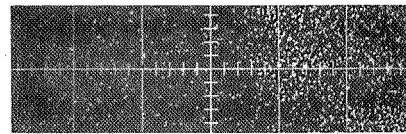
Ta



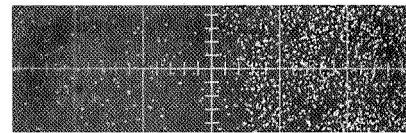
Si



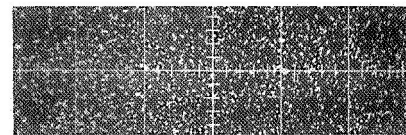
V



Mo



Ti



W

200x

FIGURE 94

SCANNING X-RAY IMAGES OF 33.6MoSi_2 - 27.6WSi_2 - 19.7TiSi_2 -
 19.1VSi_2 ON T-222
(SPECIMEN WO-423-82-15-L NOT OXIDIZED)

facilitate this comparison, white grid lines were included in each photograph so that specific regions of the specimens can be compared closely.

Photomicrographs, at 600 magnification, of the two areas analyzed on each specimen are shown in Figures 75, 79, 83, 87, and 91, and charts of element concentration versus depth beneath the coating surface for each specimen are shown in Figures 76, 80, 84, 88, and 92. The concentration profiles shown in the latter figures are smoothed averages of the analytical traces obtained from the original electron microprobe strip chart recordings.

In examining the photomicrographs and concentration profiles of both the oxidized and non-oxidized specimens that were analyzed, some trends in the extent of diffusion of the various coating elements become apparent and can be summarized as follows:

- a) Silicon diffused into the T-222 substrate to a depth of approximately 10 microns after the siliconization treatment (Figures 76, 84, and 92).
- b) A difference in diffusion rate was noted for some of the elements of each coating system on opposite sides of the specimen. For example, in the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ coating system, one side of the specimen showed that Ti and V diffused to a depth of 15 microns into the T-222 substrate and that tantalum diffused into the coating to a depth of 45 microns. On the opposite side of the specimen no diffusion of Ti and V was observed and only a diffusion depth of 15 microns was noted for tantalum. Similar discrepancies which cannot be explained at this time were observed in the other coating systems (Figures 84 and 92).
- c) In all instances Mo showed no tendency to diffuse into the T-222 substrate (Figures 76, 84, and 92).
- d) In the 400 hour-oxidized specimens of the same coating systems the diffusion zone increased four-fold from 10 microns to approximately 40 microns with silicon being the predominant diffusing specie (Figures 80 and 88).
- e) It was also noted in the oxidized specimens that Ti in the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ system, and Cr in the $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ coating systems both segregated near the surface and near or in the diffusion zone of each specimen. The region of segregation varied from side to side of each specimen as indicated in the concentration profiles (Figures 80 and 88).

- f) In the $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ coating system after oxidation, tantalum was found to have completely diffused through the entire coating, whereas in the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ coating system tantalum diffusion into the coating was inhibited. The outer portion of the coating (approximately 40 microns thick) was found free of tantalum (Figure 88).
- g) In the case of the quaternary $\text{MoSi}_2\text{-WSi}_2\text{-TiSi}_2\text{-VSi}_2$ coating system, only silicon diffusion into the substrate was found to have occurred. Approximately a 15 micron-thick region of the T-222 substrate was affected. It was observed, as in the case of the $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ system, that tantalum did not diffuse at equal rates into the coating on both sides of the coated specimens. On one side of the specimen tantalum diffused to a depth of approximately 15 microns while on the opposite side tantalum was not detected (Figure 92).

4. CONCLUSIONS

- a) As determined by pellet tests the binary WSi_2 -base silicide systems WSi_2 - CrSi_2 , WSi_2 - VSi_2 , WSi_2 - TiSi_2 are ineffective in providing 1500°F protection to tantalum alloys due to the limited solid solubility of the phases and the consequent "pest" failure of the unmodified WSi_2 . Pest failures were not, however, observed in pellet oxidation tests of the MoSi_2 - CrSi_2 , MoSi_2 - VSi_2 and MoSi_2 - TiSi_2 systems.
- b) Comparison of the three binary silicide systems MoSi_2 - CrSi_2 , MoSi_2 - TiSi_2 , and MoSi_2 - VSi_2 at concentrations of 10, 20, and 30% of the second phase indicated that the compositions MoSi_2 -10 VSi_2 , MoSi_2 -20 TiSi_2 , and MoSi_2 -30 CrSi_2 provide the best protection for T-222 alloy at temperatures of 1500°F and 2400°F . The performance of the MoSi_2 - CrSi_2 system at both test temperatures improved with increasing CrSi_2 concentration up to the upper limit of 30% CrSi_2 investigated.
- c) Oxidation life at 2400°F of the three MoSi_2 -base systems at the optimum concentration levels is generally improved by siliconization of the sintered coatings for periods of 8-16 hours at reduced pressure.
- d) Oxidation resistance of the siliconized binary MoSi_2 -base systems was not improved by preoxidation for periods up to 300 minutes at temperatures of 2700°F and 2900°F .
- e) When the three binary MoSi_2 -base systems were siliconized for 8 hours or more, a glassy surface was formed upon subsequent exposure to oxidation at temperatures of 2400°F and above. A glassy surface was not formed in any of the siliconized specimens upon exposure to oxidation at 1500°F .
- f) Although 30-50% of the specimens tested of the binary, single-layer, MoSi_2 -base, siliconized coating systems provided 100-400 hours life at 1500°F and 2400°F , reliability was considered poor due to the occurrence of defect failures at random coating sites. Reliability of these systems was not improved by depositing the coatings in two layers of identical composition so as to obtain the same overall thickness. Of the nine coating chemistries investigated, MoSi_2 -30 CrSi_2 and MoSi_2 -20 TiSi_2 yielded the best results.
- g) Miscellaneous binary, ternary, and quaternary single-layer silicide systems including CrSi_2 -20 VSi_2 , MoSi_2 -15 CrSi_2 -15 VSi_2 , siliconized Mo-15.4Ti (metallic coating), 35 MoSi_2 -35 WSi_2 -15 TiSi_2 -15 VSi_2 , and 33.6 MoSi_2 -27.6 WSi_2 -19.7 TiSi_2 -19.1 VSi_2 yielded poorer oxidation lives than the MoSi_2 -30 CrSi_2 and MoSi_2 -20 TiSi_2 systems.

h) The binary systems $\text{MoSi}_2\text{-40CrSi}_2$ and $\text{MoSi}_2\text{-20TiSi}_2$, when deposited over a barrier layer of VSi_2 to an overall coating thickness of 2.5 mils, were found to afford outstanding oxidation resistance to T-222 alloy.

Specimens of the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ two-layer system survived up to 1398 hours of cyclic testing at 1500°F and up to 824 hours of cyclic testing at 2400°F before failure.

i) Excellent reproducibility was achieved with the $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ two-layer coating system in oxidation tests at 1500°F and 2400°F . Of the five specimens tested at each temperature only one specimen failed prematurely. Four of the five specimens tested at each temperature accumulated 626 hours before the test was terminated. No failures were noted after termination of the test.

j) Bend tests (4t) indicated a loss of ductility of the T-222 alloy after oxidation testing both the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ and $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ coating systems for 400 hours at 2400°F . The "ductile life" of these coatings was not determined.

k) Electron microprobe analyses of the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$, $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ and $33.6\text{MoSi}_2\text{-27.6WSi}_2\text{-19.7TiSi}_2\text{-19.1VSi}_2$ coating systems showed similar diffusion results. The predominant diffusing specie into the T-222 substrate both before and after oxidation was silicon. Tantalum diffused from the substrate into the coating to some degree in all systems before oxidation. After oxidation testing tantalum diffused completely through the $\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ coating but tantalum diffusion appeared to be inhibited in the $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$ coating system.

5. RECOMMENDATIONS

Two coating systems ($\text{MoSi}_2\text{-40CrSi}_2/\text{VSi}_2$ and $\text{MoSi}_2\text{-20TiSi}_2/\text{VSi}_2$) have been identified with the potential for providing long term oxidation protection for T-222 alloy at temperatures between 1500°F and 2400°F . Before these coatings could be used, however, the ultimate capabilities and limitations of these systems would need to be defined. Studies which were performed for the binary silicide systems without an underlying layer of VSi_2 - but which were not pursued for the double layer system include:

- a) Coating life as a function of binary silicide composition, total coating thickness, and relative layer thickness.
- b) Effect of free silicon content and coating density on system performance, using optimum composition and thickness.
- c) Further investigation of the loss of ductility of the substrate.
- d) Impact resistance of the coating systems as a function of oxidation exposure, composition, and processing conditions.
- e) Oxidation life at intermediate temperatures, low pressures, and under slow-cycling conditions.
- f) Oxidation studies of intentionally defected specimens to determine self-healing capabilities.
- g) Application and tests of the optimized coating systems on prototype engine hardware.
- h) Mechanical property testing of coated tantalum alloy test specimens.

REFERENCES

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- (3) R. T. Wimber and A. R. Stetson, "Development of Coatings for Tantalum Alloy Nozzle Vanes," Report No. NASA CR-54529, (July 1967).

APPENDIX A

PROCESSING CONDITIONS AND OXIDATION TEST RESULTS FOR SILICIDE COATED T-222 SPECIMENS

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂-10KSi₂

COATING PROCESS PARAMETERS							OXIDATION TEST RESULTS						
Plating Conditions	Specimen Number	W0-423-30-1	W0-423-30-2	W0-423-30-3	W0-423-30-10	W0-423-30-11	W0-423-30-12						
	Dispersion Number	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1						
	Voltage	200	200	200	200	200	200						
	Milliamps	30	30	30	30	30	30						
	Time (Seconds)	30	30	30	30	30	30						
	Coating Thickness (mils)	3.2	3.2	3.2	2.4	2.4	2.4						
	Densification Press (psi)	10	10	10	10	10	10						
	Temperature (°F)	2910	2910	2910	2910	2910	2910						
	Time (hours)	2	2	2	2	2	2						
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON						
	Temperature (°F)	-	-	-	-	-	-						
	Time (hours)	-	-	-	-	-	-						
	Atmosphere	-	-	-	-	-	-						
	Weight Gain (mgs/cm²)	-	-	-	-	-	-						
	Temperature (°F)	-	-	-	-	-	-						
	Time (minutes)	-	-	-	-	-	-						
	Atmosphere	-	-	-	-	-	-						
	Weight Gain (mgs/cm²)	-	-	-	-	-	-						
	1500°F	Number of Cycles	1	1	1	-	-	-					
Oxidation Life (hours)		2	2	2	-	-	-						
Type of Failure		EDGE	SURFACE	GENERAL	-	-	-						
Appearance of Coating Surface		Non-Glassy	Non-Glassy	Non-Glassy	-	-	-						
2400°F	Number of Cycles	-	-	-	1	1	1						
	Oxidation Life (hours)	-	-	-	2	2	2						
	Type of Failure	-	-	-	GENERAL	GENERAL	EDGE						
	Appearance of Coating Surface	-	-	-	Non-Glassy	Non-Glassy	Non-Glassy						

OXIDATION TEST RESULTS

COATING PROCESS PARAMETERS

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: *MoSi₂ - 10VSi₂*

COATING PROCESS PARAMETERS		Specimen Number									
OXIDATION TEST RESULTS	Plating Conditions	Dispersion Number	W6-423-30-4	W6-423-30-5	W6-423-30-6	W6-423-30-13	W6-423-30-14	W6-423-30-15			
		Voltage	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1
		Milliamps	200	200	200	200	200	200	200	200	200
		Time (Seconds)	30	30	30	30	30	30	30	30	30
		Coating Thickness (mils)	15	30	30	30	30	30	30	30	30
	Sintering	Densification Press (tsi)	2.6	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
		Temperature (°F)	10	10	10	10	10	10	10	10	10
		Time (hours)	2910	2910	2910	2910	2910	2910	2910	2910	2910
		Atmosphere	2	2	2	2	2	2	2	2	2
		Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Preoxidation	Silicizing	Temperature (°F)	2370	2370	2370	2370	2370	2370	2370	2370	2370
		Time (hours)	4	4	4	4	4	4	4	4	4
		Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
		Weight Gain (mgs/cm ²)	2.24	1.12	3.51	3.1	4.43	1.16			
		Temperature (°F)	-	-	-	-	-	-	-	-	-
	1500 °F	Time (minutes)	-	-	-	-	-	-	-	-	-
		Atmosphere	-	-	-	-	-	-	-	-	-
		Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-	-	-
		Number of Cycles	1	1	1	1	1	1	1	1	1
		Oxidation Life (hours)	2	2	2	2	2	2	2	2	2
2400 °F	General	Type of Failure	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL
		Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy
		Number of Cycles	-	-	-	-	-	-	-	-	-
		Oxidation Life (hours)	-	-	-	-	-	-	-	-	-
		Type of Failure	-	-	-	-	-	-	-	-	-
	Slightly Glassy	Appearance of Coating Surface	-	-	-	-	-	-	-	-	-
		Number of Cycles	-	-	-	-	-	-	-	-	-
		Oxidation Life (hours)	-	-	-	-	-	-	-	-	-
		Type of Failure	-	-	-	-	-	-	-	-	-
		Appearance of Coating Surface	-	-	-	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-10VSi_2$

COATING PROCESS PARAMETERS				Plating Conditions				Preoxidation				1500°F				2400°F			
Specimen Number	W0-423-30-7			W0-423-30-8	W0-423-30-9			W0-423-30-10	W0-423-30-11			W0-423-30-12	W0-423-30-13			W0-423-30-14	W0-423-30-15		
Dispersion Number	2-3A-1			2-3A-1	2-3A-1			2-3A-1	2-3A-1			2-3A-1	2-3A-1			2-3A-1	2-3A-1		
Voltage	200			200	200			200	200			200	200			200	200		
Milliamps	30			30	30			30	30			30	30			30	30		
Time (Seconds)	30			30	30			30	30			30	30			30	30		
Coating Thickness (mils)	4.0			4.0	4.0			4.0	4.0			4.0	4.0			4.0	4.0		
Densification Press (tsi)	10			10	10			10	10			10	10			10	10		
Temperature (°F)	2910			2910	2910			2910	2910			2910	2910			2910	2910		
Time (hours)	2			2	2			2	2			2	2			2	2		
Atmosphere	ARGON			ARGON	ARGON			ARGON	ARGON			ARGON	ARGON			ARGON	ARGON		
Temperature (°F)	2370			2370	2370			2370	2370			2370	2370			2370	2370		
Time (hours)	7			7	7			7	7			7	7			7	7		
Atmosphere	VACUUM			VACUUM	VACUUM			VACUUM	VACUUM			VACUUM	VACUUM			VACUUM	VACUUM		
Weight Gain (mgs/cm ²)	5.32			5.80	9.31			5.58	6.72			5.25	5.25			5.25	5.25		
Temperature (°F)	-			-	-			-	-			-	-			-	-		
Time (minutes)	-			-	-			-	-			-	-			-	-		
Atmosphere	-			-	-			-	-			-	-			-	-		
Weight Gain (mgs/cm ²)	-			-	-			-	-			-	-			-	-		
Number of Cycles	1			1	2			2	4			4	4			4	4		
Oxidation Life (hours)	2			2	2			2	2			2	2			2	2		
Type of Failure	EDGE			EDGE	CORNER			EDGE	CORNER			EDGE	CORNER			EDGE	CORNER		
Appearance of Coating Surface	Non-Glassy			Non-Glassy	Non-Glassy			Non-Glassy	Non-Glassy			Non-Glassy	Non-Glassy			Non-Glassy	Non-Glassy		
Number of Cycles	-			-	-			-	-			-	-			-	-		
Oxidation Life (hours)	-			-	-			-	-			-	-			-	-		
Type of Failure	-			-	-			-	-			-	-			-	-		
Appearance of Coating Surface	-			-	-			-	-			-	-			-	-		

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20VSi_2$

COATING PROCESS PARAMETERS		W6-423-14-1	W6-423-14-2	W6-423-14-3	W6-423-14-10	W6-423-14-11	W6-423-14-12
Plating Conditions	Specimen Number	W6-423-14-1	W6-423-14-2	W6-423-14-3	W6-423-14-10	W6-423-14-11	W6-423-14-12
	Dispersion Number	2-3B-3	2-3B-3	2-3B-3	2-3B-3	2-3B-3	2-3B-3
	Voltage	200	200	200	200	200	200
	Milliamps	30	30	30	30	30	30
	Time (Seconds)	60	60	60	60	6	60
Sintering	Coating Thickness (mils)	3.3	3.4	3.4	3.3	3.6	3.6
	Densification Press (tsi)	10	10	10	10	10	10
	Temperature ($^{\circ}F$)	2910	2910	2910	2910	2910	2910
	Time (hours)	2	2	2	2	2	2
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Silicizing	Temperature ($^{\circ}F$)	-	-	-	-	-	-
	Time (hours)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Temperature ($^{\circ}F$)	-	-	-	-	-	-
Preoxidation	Time (minutes)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Number of Cycles	1	1	1	-	-	-
	Oxidation Life (hours)	2	2	2	-	-	-
1500 $^{\circ}F$	Type of Failure	GENERAL	GENERAL	GENERAL	-	-	-
	Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	-	-	-
	Number of Cycles	-	-	-	1	1	1
	Oxidation Life (hours)	-	-	-	2	2	2
	Type of Failure	-	-	-	GENERAL	GENERAL	GENERAL
2400 $^{\circ}F$	Appearance of Coating Surface	-	-	-	Non-Glassy	Non-Glassy	Non-Glassy
	Number of Cycles	-	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-	-
	Type of Failure	-	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 20VSi_2$

COATING PROCESS PARAMETERS									
Specimen Number	W0-423-14-4	W0-423-14-5	W0-423-14-6	W0-423-14-13	W0-423-14-14	W0-423-14-15			
	2-3B-3	2-3B-3	2-3B-3	2-3B-3	2-3B-3	2-3B-3			
Dispersion Number	200	200	200	200	200	200			
Voltage	30	30	30	30	30	30			
Milliamps	60	60	60	60	60	60			
Time (Seconds)	3.3	3.3	3.6	3.7	3.7	3.7			
Coating Thickness (mils)	10	10	10	10	10	10			
Densification Press (tsi)	2910	2910	2910	2910	2910	2910			
Temperature ($^{\circ}F$)	2	2	2	2	2	2			
Time (hours)	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON			
Atmosphere	2370	2370	2370	2370	2370	2370			
Temperature ($^{\circ}F$)	4	4	4	4	4	4			
Time (hours)	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM			
Atmosphere	4.86	3.79	4.67	4.32	4.20	3.20			
Weight Gain (mgs/cm ²)	-	-	-	-	-	-			
Temperature ($^{\circ}F$)	-	-	-	-	-	-			
Time (minutes)	-	-	-	-	-	-			
Atmosphere	-	-	-	-	-	-			
Weight Gain (mgs/cm ²)	1	1	1						
Number of Cycles	2	2	2						
Oxidation Life (hours)	EDGE	EDGE	EDGE						
Type of Failure	Non-GLASSY	Non-GLASSY	Non-GLASSY						
Appearance of Coating Surface									
Number of Cycles				1	7	1			
Oxidation Life (hours)				2	14	2			
Type of Failure				CORNER	EDGE	EDGE			
Appearance of Coating Surface				Slightly GLASSY	Slightly GLASSY	Slightly GLASSY			

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂ - 20VSi₂

COATING PROCESS PARAMETERS					OXIDATION TEST RESULTS				
Plating Conditions					1500°F				
Specimen Number	W6-423-14-7	W6-423-14-8	W6-423-14-9	W6-423-14-16	W6-423-14-17	W6-423-14-18			
Dispersion Number	2-38-3	2-38-3	2-38-3	2-38-3	2-38-3	2-38-3			
Voltage	200	200	200	200	200	200			
Milliamps	30	30	30	30	30	30			
Time (Seconds)	60	60	60	60	60	60			
Coating Thickness (mils)	3.4	3.4	3.5	3.6	3.6	3.6			
Densification Press (tsi)	10	10	10	10	10	10			
Temperature (°F)	2910	2910	2910	2910	2910	2910			
Time (hours)	2	2	2	2	2	2			
Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON			
Temperature (°F)	2370	2370	2370	2370	2370	2370			
Time (hours)	8	8	8	8	8	8			
Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM			
Weight Gain (mgs/cm ²)	9.30	8.19	4.22	4.19	8.74	7.07			
Temperature (°F)	-	-	-	-	-	-			
Time (minutes)	-	-	-	-	-	-			
Atmosphere	-	-	-	-	-	-			
Weight Gain (mgs/cm ²)	-	-	-	-	-	-			
Number of Cycles	1	1	1	-	-	-			
Oxidation Life (hours)	2	2	2	-	-	-			
Type of Failure	EDGE	EDGE	GENERAL	-	-	-			
Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-			
Number of Cycles	-	-	-	2	15	8			
Oxidation Life (hours)	-	-	-	4	30	16			
Type of Failure	-	-	-	-	-	-			
Appearance of Coating Surface	-	-	-	SURFACE	EDGE	SURFACE			
				SLIGHTLY GLASSY	VERY GLASSY	VERY GLASSY			

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 30VSi_2$

COATING PROCESS PARAMETERS									
Plating Conditions	Specimen Number	W0-423-16-1	W0-423-16-2	W0-423-16-3	W0-423-16-10	W0-423-16-11	W0-423-16-12		
	Dispersion Number	2-3C	2-3C	2-3C	2-3A	2-3A	2-3A		
	Voltage	200	200	200	200	200	200		
	Milliamps	25	25	25	30	30	30		
	Time (Seconds)	120	120	120	120	120	120		
	Coating Thickness (mils)	5.45	4.9	5.45	5.0	5.0	5.0		
	Densification Press (tsi)	30	30	30	30	30	30		
	Temperature (°F)	3090	3090	3090	3090	3090	3090		
	Time (hours)	1	1	1	1	1	1		
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON		
Sintering	Temperature (°F)	-	-	-	-	-	-		
	Time (hours)	-	-	-	-	-	-		
	Atmosphere	-	-	-	-	-	-		
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-		
	Temperature (°F)	-	-	-	-	-	-		
Preoxidation	Time (minutes)	-	-	-	-	-	-		
	Atmosphere	-	-	-	-	-	-		
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-		
	Number of Cycles	1	1	1	-	-	-		
	Oxidation Life (hours)	2	2	2	-	-	-		
1500°F	Type of Failure	GENERAL	GENERAL	GENERAL	-	-	-		
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-		
	Number of Cycles	-	-	-	1	1	1		
	Oxidation Life (hours)	-	-	-	2	2	2		
	Type of Failure	-	-	-	EDGE	EDGE	EDGE		
2400°F	Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY		
	Number of Cycles	-	-	-	-	-	-		
	Oxidation Life (hours)	-	-	-	-	-	-		
	Type of Failure	-	-	-	-	-	-		
	Appearance of Coating Surface	-	-	-	-	-	-		

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 30VS_{12}$

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Plating Conditions										1500 °F																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Specimen Number	W0-423-16-4	W0-423-16-5	W0-423-16-6	W0-423-16-13	W0-423-16-14	W0-423-16-15	Dispersion Number	2-3C	2-3C	2-3C	2-3A	2-3A	2-3A	2-3A	2-3A	2-3A	Voltage	200	200	200	200	200	200	200	200	200	200	200	200	Milliamps	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 30VSi_2$

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
Specimen Number	Plating Conditions			1500 °F	2400 °F		
	W0-423-16-7	W0-423-16-8	W0-423-16-9				
Dispersion Number	2-3C	2-3C	2-3C	2-3A	2-3A	2-3A	2-3A
Voltage	200	200	200	200	200	200	200
Milliamps	30	30	30	30	30	30	30
Time (Seconds)	120	120	120	120	120	120	120
Coating Thickness (mils)	5.3	5.3	5.3	5.0	5.0	5.0	5.0
Densification Press (tsi)	30	30	30	30	30	30	30
Temperature (°F)	3090	3090	3090	3090	3090	3090	3090
Time (hours)	1	1	1	1	1	1	1
Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Temperature (°F)	2370	2370	2370	2370	2370	2370	2370
Time (hours)	8	8	8	8	8	8	8
Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Weight Gain (mgs/cm ²)	3.21	4.65	4.43	5.13	3.91	4.06	4.06
Temperature (°F)	-	-	-	-	-	-	-
Time (minutes)	-	-	-	-	-	-	-
Atmosphere	-	-	-	-	-	-	-
Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-
Number of Cycles	1	1	1	-	-	-	-
Oxidation Life (hours)	2	2	2	-	-	-	-
Type of Failure	GENERAL	GENERAL	GENERAL	-	-	-	-
Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-	-
Number of Cycles	-	-	-	17	18	19	19
Oxidation Life (hours)	-	-	-	146	148	164	164
Type of Failure	-	-	-	EDGE SURFACE	EDGE SURFACE	EDGE SURFACE	EDGE SURFACE
Appearance of Coating Surface	-	-	-	VERY GLASSY	VERY GLASSY	VERY GLASSY	VERY GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-10TiSi_2$

COATING PROCESS PARAMETERS							OXIDATION TEST RESULTS						
Specimen Number	Wo-423-24-1	Wo-423-24-2	Wo-423-24-3	Wo-423-24-10	Wo-423-24-11	Wo-423-24-12	Specimen Number	Wo-423-24-1	Wo-423-24-2	Wo-423-24-3	Wo-423-24-10	Wo-423-24-11	Wo-423-24-12
	2-4A1	2-4A1	2-4A1	2-4A1	2-4A1	2-4A1		2-4A1	2-4A1	2-4A1	2-4A1	2-4A1	2-4A1
Dispersion Number	150	150	150	150	150	150	Dispersion Number	150	150	150	150	150	150
Voltage	35	35	35	35	35	35	Voltage	35	35	35	35	35	35
Milliamps	60	60	60	60	60	60	Milliamps	60	60	60	90	90	90
Time (Seconds)	3.75	3.75	3.74	3.0	3.0	3.0	Time (Seconds)	3.75	3.75	3.74	3.0	3.0	3.0
Coating Thickness (mils)	10	10	10	10	10	10	Coating Thickness (mils)	10	10	10	10	10	10
Densification Press (tsi)	2910	2910	2910	2910	2910	2910	Densification Press (tsi)	2910	2910	2910	2910	2910	2910
Temperature (°F)	2	2	2	2	2	2	Temperature (°F)	2	2	2	2	2	2
Time (hours)	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	Time (hours)	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Atmosphere	-	-	-	-	-	-	Atmosphere	-	-	-	-	-	-
Temperature (°F)	-	-	-	-	-	-	Temperature (°F)	-	-	-	-	-	-
Time (hours)	-	-	-	-	-	-	Time (hours)	-	-	-	-	-	-
Atmosphere	-	-	-	-	-	-	Atmosphere	-	-	-	-	-	-
Weight Gain (mgs/cm ²)	-	-	-	-	-	-	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
Temperature (°F)	-	-	-	-	-	-	Temperature (°F)	-	-	-	-	-	-
Time (minutes)	-	-	-	-	-	-	Time (minutes)	-	-	-	-	-	-
Atmosphere	-	-	-	-	-	-	Atmosphere	-	-	-	-	-	-
Weight Gain (mgs/cm ²)	-	-	-	-	-	-	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
Number of Cycles	1	1	1	1	1	1	Number of Cycles	1	1	1	1	1	1
Oxidation Life (hours)	2	2	2	2	2	2	Oxidation Life (hours)	2	2	2	2	2	2
Type of Failure	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	Type of Failure	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL
Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY
Number of Cycles	-	-	-	-	-	-	Number of Cycles	-	-	-	1	1	1
Oxidation Life (hours)	-	-	-	-	-	-	Oxidation Life (hours)	-	-	-	2	2	2
Type of Failure	-	-	-	-	-	-	Type of Failure	-	-	-	GENERAL	GENERAL	GENERAL
Appearance of Coating Surface	-	-	-	-	-	-	Appearance of Coating Surface	-	-	-	NON-GLASSY	NON-GLASSY	NON-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-10TiSi_2$

COATING PROCESS PARAMETERS						OXIDATION TEST RESULTS					
Plating Conditions	Specimen Number	W0-423-24-4	W0-423-24-5	W0-423-24-6	W0-423-24-13	W0-423-24-14	W0-423-24-15				
	Dispersion Number	2-4A1	2-4A1	2-4A1	2-4A1	2-4A1	2-4A1				
	Voltage	150	150	150	150	150	150				
	Milliamps	35	35	35	35	45	45				
	Time (Seconds)	60	90	90	90	90	105				
	Coating Thickness (mils)	3.75	3.7	3.7	3.0	3.0	3.0				
Sintering	Densification Press (tsi)	10	10	10	10	10	10				
	Temperature (°F)	2910	2910	2910	2910	2910	2910				
	Time (hours)	2	2	2	2	2	2				
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON				
	Temperature (°F)	2370	2370	2370	2370	2370	2370				
	Time (hours)	4	4	4	4	4	8				
Preoxidation	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM				
	Weight Gain (mgs/cm ²)	2.77	1.17	1.36	2.76	1.13	4.17				
	Temperature (°F)	-	-	-	-	-	-				
	Time (minutes)	-	-	-	-	-	-				
	Atmosphere	-	-	-	-	-	-				
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-				
1500°F	Number of Cycles	2	1	1	-	-	-				
	Oxidation Life (hours)	4	2	2	-	-	-				
	Type of Failure	GENERAL	GENERAL	GENERAL	-	-	-				
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-				
	Number of Cycles	-	-	-	2	4	2				
	Oxidation Life (hours)	-	-	-	-	-	-				
2400°F	Type of Failure	-	-	-	-	-	-				
	Appearance of Coating Surface	-	-	-	-	-	-				

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂-10T:Si₂

COATING PROCESS PARAMETERS				W6-423-24-7	W6-423-24-8	W6-423-24-9	W6-423-24-16	W6-423-24-17	W6-423-24-18
Plating Conditions	Specimen Number			2-4A1	2-4A1	2-4A1	2-4A1	2-4A1	2-4A1
	Dispersion Number			150	150	150	150	150	150
	Voltage			35	35	35	45	45	45
	Milliamps			90	90	90	120	120	120
Sintering	Time (Seconds)			3.7	3.7	3.7	3.1	3.0	3.0
	Coating Thickness (mils)			10	10	10	10	10	10
	Densification Press (tsi)			2910	2910	2910	2910	2910	2910
	Temperature (°F)			2	2	2	2	2	2
Silicomizing	Time (hours)			ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
	Temperature (°F)			2370	2370	2370	2370	2370	2370
	Time (hours)			8	8	8	8	8	8
	Atmosphere			VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Preoxidation	Weight Gain (mgs/cm ²)			3.93	3.72	3.98	4.17	4.55	9.75
	Temperature (°F)			-	-	-	-	-	-
	Time (minutes)			-	-	-	-	-	-
	Atmosphere			-	-	-	-	-	-
OXIDATION TEST RESULTS	Weight Gain (mgs/cm ²)			-	-	-	-	-	-
	Number of Cycles			5	3	5	-	-	-
	Oxidation Life (hours)			10	6	10	-	-	-
	Type of Failure			SURFACE	GENERAL	EDGE	-	-	-
2400°F	Appearance of Coating Surface			Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-
	Number of Cycles			-	-	-	3	3	49
	Oxidation Life (hours)			-	-	-	6	6	320
	Type of Failure			-	-	-	SURFACE	SURFACE	EDGE
Appearance of Coating Surface				-	-	-	SIGHTLY GLASSY	SIGHTLY GLASSY	VERY GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 20TiSi_2$

COATING PROCESS PARAMETERS									
Plating Conditions	Specimen Number	W6-423-26-1	W6-423-26-2	W6-423-26-3	W6-423-26-10	W6-423-26-11	W6-423-26-12		
	Dispersion Number	2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4
	Voltage	150	150	150	150	150	150	150	150
	Milliamps	38	35	35	37	35	38	38	38
	Time (Seconds)	45	40	45	50	60	60	60	60
	Coating Thickness (mils)	3.5	3.0	3.2	2.9	3.5	3.2	3.2	3.2
	Densification Press (psi)	10	10	10	10	10	10	10	10
	Temperature (°F)	2910	2910	2910	2910	2910	2910	2910	2910
	Time (hours)	2	2	2	2	2	2	2	2
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Sintering	Temperature (°F)	-	-	-	-	-	-	-	-
	Time (hours)	-	-	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-	-
	Temperature (°F)	-	-	-	-	-	-	-	-
Preoxidation	Time (minutes)	-	-	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-	-
	Number of Cycles	1	1	1	-	-	-	-	-
	Oxidation Life (hours)	2	2	2	-	-	-	-	-
OXIDATION TEST RESULTS	Type of Failure	EDGE	SURFACE	EDGE	-	-	-	-	-
	Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	-	-	-	-	-
	Number of Cycles	-	-	-	1	1	1	1	1
	Oxidation Life (hours)	-	-	-	2	2	2	2	2
	Type of Failure	-	-	-	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	General	General	General	General	General
	Number of Cycles	-	-	-	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-	-	-	-
	Type of Failure	-	-	-	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂ - 20TiSi₂

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS									
Specimen Number	Plating Conditions	1500 °F									
		W0-423-26-4	W0-423-26-5	W0-423-26-6	W0-423-26-13	W0-423-26-14	W0-423-26-15				
Dispersion Number		2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4				
Voltage		150	150	150	150	150	150				
Milliamps		35	35	38	35	38	35				
Time (Seconds)		45	50	50	80	80	90				
Coating Thickness (mils)		3.1	3.1	3.1	3.3	3.0	3.4				
Densification Press (tsi)		10	10	10	10	10	10				
Temperature (°F)		2910	2910	2910	2910	2910	2910				
Time (hours)	Sintering	2	2	2	2	2	2				
Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON				
Temperature (°F)	Silicidizing	2370	2370	2370	2370	2370	2370				
Time (hours)		4	4	4	4	4	4				
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM				
Weight Gain (mgs/cm ²)		3.18	3.21	1.94	1.88	3.42	3.62				
Temperature (°F)	Preoxidation	-	-	-	-	-	-				
Time (minutes)		-	-	-	-	-	-				
Atmosphere		-	-	-	-	-	-				
Weight Gain (mgs/cm ²)		-	-	-	-	-	-				
Number of Cycles		18	14	1	-	-	-				
Oxidation Life (hours)		64	42	2	-	-	-				
Type of Failure		SURFACE	EDGE	EDGE	-	-	-				
Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-				
Number of Cycles		-	-	-	1	34	31				
Oxidation Life (hours)		-	-	-	2	138	120				
Type of Failure		-	-	-	EDGE	GENERAL	EDGE				
Appearance of Coating Surface		-	-	-	SILTY-GLASSY	SILTY-GLASSY	SILTY-GLASSY				

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2$

COATING PROCESS PARAMETERS									
Plating Conditions									
Specimen Number	W0-423-26-7	W0-423-26-8	W0-423-26-9	W0-423-26-16	W0-423-26-17	W0-423-26-18			
Dispersion Number	2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4	2-4B-4			
Voltage	150	150	150	150	150	150			
Milliamps	35	35	35	35	35	35			
Time (Seconds)	50	60	60	90	90	90			
Coating Thickness (mils)	3.0	3.2	3.1	3.3	3.1	3.1			
Densification Press (tsi)	10	10	10	10	10	10			
Temperature (°F)	2910	2910	2910	2910	2910	2910			
Time (hours)	2	2	2	2	2	2			
Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON			
Temperature (°F)	2370	2370	2370	2370	2370	2370			
Time (hours)	8	8	8	8	8	8			
Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM			
Weight Gain (mgs/cm ²)	7.00	6.68	0.08	6.14	2.45	6.23			
Temperature (°F)	-	-	-	-	-	-			
Time (minutes)	-	-	-	-	-	-			
Atmosphere	-	-	-	-	-	-			
Weight Gain (mgs/cm ²)	-	-	-	-	-	-			
Number of Cycles	29	26	12	-	-	-			
Oxidation Life (hours)	114	94	40	-	-	-			
Type of Failure	SURFACE	EDGE	SURFACE	-	-	-			
Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-			
Number of Cycles	-	-	-	2	11	72			
Oxidation Life (hours)	-	-	-	4	22	363			
Type of Failure	-	-	-	EDGE	SURFACE	SURFACE			
Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	VERY GLASSY			

OXIDATION TEST RESULTS

COATING PROCESS PARAMETERS

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂-30TiSi₂

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
Plating Conditions	Specimen Number	W6-423-28-1	W6-423-28-2	W6-423-28-3	W6-423-28-10	W6-423-28-11	W6-423-28-12
	Dispersion Number	2-4C-6	2-4C-6	2-4C-6	2-4C-5	2-4C-5	2-4C-5
	Voltage	200	200	200	200	200	200
	Milliamps	30	30	30	28	30	35
	Time (Seconds)	30	30	30	60	60	30
	Coating Thickness (mils)	3.7	3.2	3.2	3.3	3.1	3.5
	Densification Press (tsi)	10	10	10	10	10	10
	Temperature (°F)	3090	3090	3090	3090	3090	3090
	Time (hours)	1	1	1	1	1	1
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Sintering	Temperature (°F)	-	-	-	-	-	-
	Time (hours)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Temperature (°F)	-	-	-	-	-	-
Preoxidation	Time (minutes)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Number of Cycles	1	1	1	-	-	-
	Oxidation Life (hours)	2	2	2	-	-	-
1500°F	Type of Failure	GENERAL	GENERAL	GENERAL	-	-	-
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-
	Number of Cycles	-	-	-	1	1	1
	Oxidation Life (hours)	-	-	-	2	2	2
	Type of Failure	-	-	-	SURFACE	EDGE	SURFACE
2400°F	Appearance of Coating Surface	-	-	-	NON-GLASSY	NON-GLASSY	GLASSY GLASSY
	Number of Cycles	-	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-	-
	Type of Failure	-	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-30TiSi_2$

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS									
Plating Conditions					Specimen Number	Wb-423-28-4	Wb-423-28-5	Wb-423-28-6	Wb-423-28-13	Wb-423-28-4	Wb-423-28-15								
					Dispersion Number	2-4C-5	2-4C-5	2-4C-5	2-4C-6	2-4C-6	2-4C-6								
					Voltage	150	200	200	200	200	200								
					Milliamps	32	30	32	30	30	30								
					Time (Seconds)	90	30	30	30	30	30								
					Coating Thickness (mils)	3.1	3.1	3.1	4.0	3.7	3.7								
					Densification Press (tsi)	10	10	10	10	10	10								
					Temperature (°F)	3090	3090	3090	3090	3090	3090								
Sintering					Time (hours)	1	1	1	1	1	1								
					Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON								
					Temperature (°F)	2370	2370	2370	2370	2370	2370								
					Time (hours)	4	4	4	4	4	4								
Siliconizing					Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM								
					Weight Gain (mgs/cm ²)	3.35	1.41	2.56	1.48	2.67	2.60								
					Temperature (°F)	-	-	-	-	-	-								
					Time (minutes)	-	-	-	-	-	-								
					Atmosphere	-	-	-	-	-	-								
					Weight Gain (mgs/cm ²)	-	-	-	-	-	-								
					Number of Cycles	11	1	3	-	-	-								
1500 °F					Oxidation Life (hours)	36	2	6	-	-	-								
					Type of Failure	GENERAL	SURFACE	SURFACE	-	-	-								
					Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-								
					Number of Cycles	-	-	-	3	1	3								
					Oxidation Life (hours)	-	-	-	6	2	6								
2400 °F					Type of Failure	-	-	-	CORNER	EDGE	SURFACE								
					Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY								

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂-307Si₂

COATING PROCESS PARAMETERS		Specimen Number	W6-423-28-7	W6-423-28-8	W6-423-28-9	W6-423-28-16	W6-423-28-17	W6-423-28-18
Plating Conditions	Dispersion Number		2-4C-6	2-4C-6	2-4C-6	2-4C-6	2-4C-6	2-4C-6
	Voltage		200	200	200	200	200	200
	Milliamps		50	50	50	50	50	50
Sintering	Time (Seconds)		30	30	30	30	30	30
	Coating Thickness (mils)		3.7	3.7	3.7	3.7	3.7	3.7
	Densification Press (tsi)		10	10	10	10	10	10
Silicizing	Temperature (°F)		3090	3090	3090	3090	3090	3090
	Time (hours)		1	1	1	1	1	1
	Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Preoxidation	Temperature (°F)		2370	2370	2370	2370	2370	2370
	Time (hours)		8	8	8	8	8	8
	Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
1500° F	Weight Gain (mgs/cm ²)		0.80	2.78	0.91	2.83	1.04	1.83
	Temperature (°F)		-	-	-	-	-	-
	Time (minutes)		-	-	-	-	-	-
2400° F	Atmosphere		-	-	-	-	-	-
	Weight Gain (mgs/cm ²)		-	-	-	-	-	-
	Number of Cycles		1	1	1	-	-	-
OXIDATION TEST RESULTS	Oxidation Life (hours)		2	2	2	-	-	-
	Type of Failure		GENERAL	SURFACE	SURFACE	-	-	-
	Appearance of Coating Surface		Non-Glassy	Non-Glassy	Non-Glassy	-	-	-
	Number of Cycles		-	-	-	4	1	3
	Oxidation Life (hours)		-	-	-	8	2	6
	Type of Failure		-	-	-	EDGE	EDGE	EDGE
		Appearance of Coating Surface	-	-	-	Slightly Glassy	Slightly Glassy	Slightly Glassy

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂ - 10CrSi₂

COATING PROCESS PARAMETERS		Specimen Number	W6-423-18-1	W6-423-18-2	W6-423-18-3	W6-423-18-10	W6-423-18-11	W6-423-18-12
Plating Conditions	Dispersion Number	2-5A-1	2-5A-1	2-5A-2	2-5A-1	2-5A-1	2-5A-1	2-5A-1
	Voltage	150	150	150	150	150	150	150
	Milliamps	30	30	35	35	35	35	35
	Time (Seconds)	45	45	40	45	45	45	45
Sintering	Coating Thickness (mils)	3.6	3.9	3.2	3.0	3.1	2.9	2.9
	Densification Press (tsi)	10	10	10	10	10	10	10
	Temperature (°F)	2910	2910	2910	2910	2910	2910	2910
	Time (hours)	2	2	2	2	2	2	2
Silicizing	Atmosphere	Argon	Argon	Argon	Argon	Argon	Argon	Argon
	Temperature (°F)	-	-	-	-	-	-	-
	Time (hours)	-	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-	-
Preoxidation	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-
	Temperature (°F)	-	-	-	-	-	-	-
	Time (minutes)	-	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-	-
1500 °F	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-
	Number of Cycles	1	1	1	1	1	1	1
	Oxidation Life (hours)	2	2	2	2	2	2	2
	Type of Failure	EDGE	EDGE	EDGE	EDGE	EDGE	EDGE	EDGE
2400 °F	Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy
	Number of Cycles	-	-	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-	-	-
	Type of Failure	-	-	-	-	-	-	-
		Appearance of Coating Surface	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂-10CrSi₂

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS									
Specimen Number	Plating Conditions	Wo-423-18-4	Wo-423-18-5	Wo-423-18-6	Wo-423-18-13	Wo-423-18-14	Wo-423-18-15				
		2-5A-2	2-5A-2	2-5A-2	2-5A-2	2-5A-2	2-5A-2				
Dispersion Number		200	200	200	200	200	200				
Voltage		30	25	25	25	30	30				
Milliamps		30	45	60	60	30	30				
Time (Seconds)		5.4	4.7	3.5	4.9	5.4	5.4				
Coating Thickness (mils)		10	10	10	10	10	10				
Densification Press (tsi)		2910	2910	2910	2910	2910	2910				
Temperature (°F)		2	2	2	2	2	2				
Time (hours)		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON				
Atmosphere		2370	2370	2370	2370	2370	2370				
Temperature (°F)		4	4	4	4	4	4				
Time (hours)		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM				
Atmosphere		6.64	5.01	2.71	5.55	3.44	3.10				
Weight Gain (mgs/cm ²)		-	-	-	-	-	-				
Temperature (°F)		-	-	-	-	-	-				
Time (minutes)		-	-	-	-	-	-				
Atmosphere		-	-	-	-	-	-				
Weight Gain (mgs/cm ²)		-	-	-	-	-	-				
Number of Cycles		62	52	1	-	-	-				
Oxidation Life (hours)		390	294	2	-	-	-				
Type of Failure		EDGE	SURFACE	EDGE	-	-	-				
Appearance of Coating Surface	1500°F	Non-Glassy	Non-Glassy	Non-Glassy	-	-	-				
Number of Cycles		-	-	-	1	1	1				
Oxidation Life (hours)	2400°F	-	-	-	2	2	2				
Type of Failure		-	-	-	SURFACE	SURFACE	SURFACE				
Appearance of Coating Surface		-	-	-	SIGHTLY GLASSY	SIGHTLY GLASSY	SIGHTLY GLASSY				

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: *MoSi₂-10 CrSi₂*

COATING PROCESS PARAMETERS				W6-423-18-7	W6-423-18-8	W6-423-18-9	W6-423-18-16	W6-423-18-17	W6-423-18-18
COATING PROCESS PARAMETERS	Plating Conditions	Specimen Number		W6-423-18-7	W6-423-18-8	W6-423-18-9	W6-423-18-16	W6-423-18-17	W6-423-18-18
		Dispersion Number		2-5A-2	2-5A-2	2-5A-2	2-5A-2	2-5A-2	2-5A-2
		Voltage		200	200	200	200	200	200
		Milliamps		25	30	30	25	25	30
		Time (Seconds)		60	30	30	60	60	30
	Sintering	Coating Thickness (mils)		5.5	5.4	4.7	3.5	3.5	5.5
		Densification Press (tsi)		10	10	10	10	10	10
		Temperature (°F)		2910	2910	2910	2910	2910	2910
		Time (hours)		2	2	2	2	2	2
		Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
OXIDATION TEST RESULTS	Silicizing	Temperature (°F)		2370	2370	2370	2370	2370	2370
		Time (hours)		8	8	8	8	8	8
		Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
		Weight Gain (mgs/cm ²)		5.43	1.52	3.80	2.72	1.50	1.84
		Temperature (°F)		-	-	-	-	-	-
	Preoxidation	Time (minutes)		-	-	-	-	-	-
		Atmosphere		-	-	-	-	-	-
		Weight Gain (mgs/cm ²)		-	-	-	-	-	-
		Number of Cycles		1	1	1	-	-	-
		Oxidation Life (hours)		2	2	2	-	-	-
OXIDATION TEST RESULTS	1500°F	Type of Failure		EDGE	GENERAL	EDGE	-	-	-
		Appearance of Coating Surface		Non-Glassy	Non-Glassy	Non-Glassy	-	-	-
		Number of Cycles		-	-	-	3	1	4
		Oxidation Life (hours)		-	-	-	6	2	8
		Type of Failure		-	-	-	EDGE	CORNER	SURFACE
	2400°F	Appearance of Coating Surface		-	-	-	Slightly Glassy	Slightly Glassy	Slightly Glassy

COATING: MoSi₂-20CrSi₂

A-22

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂ - 20CrSi₂

COATING PROCESS PARAMETERS				WO-423-20-4	WO-423-20-5	WO-423-20-6	WO-423-20-13	WO-423-20-14	WO-423-20-15
Plating Conditions	Specimen Number			2-5B	2-5B	2-5B	2-5B	2-5B	2-5B
	Dispersion Number			200	200	150	200	200	150
	Voltage			70	65	70	65	70	75
	Milliamps			240	240	120	150	150	120
	Coating Thickness (mils)			5.0	5.0	4.7	6.0	5.0	4.7
Sintering	Densification Press (tsi)			30	30	30	30	30	30
	Temperature (°F)			2910	2910	2910	2910	2910	2910
Silicizing	Time (hours)			2	2	2	2	2	2
	Atmosphere			ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
	Temperature (°F)			2370	2370	2370	2370	2370	2370
Preoxidation	Time (hours)			4	4	4	4	4	4
	Atmosphere			VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Weight Gain (mgs/cm ²)			2.82	2.49	2.69	3.11	3.16	3.28
	Temperature (°F)			-	-	-	-	-	-
	Time (minutes)			-	-	-	-	-	-
1500°F	Atmosphere			-	-	-	-	-	-
	Weight Gain (mgs/cm ²)			-	-	-	-	-	-
	Number of Cycles			13	36	20	-	-	-
	Oxidation Life (hours)			54	142	80	-	-	-
	Type of Failure			EDGE	CORNER	EDGE	-	-	-
2400°F	Appearance of Coating Surface			Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-
	Number of Cycles			-	-	-	16	5	3
	Oxidation Life (hours)			-	-	-	60	10	6
	Type of Failure			-	-	-	CORNER SURFACE SLIGHTLY GLASSY	CORNER SLIGHTLY GLASSY	EDGE SURFACE NON-GLASSY
	Appearance of Coating Surface			-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	NON-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 20CrSi_2$

COATING PROCESS PARAMETERS		Specimen Number	W0-423-20-7	W0-423-20-8	W0-423-20-9	W0-423-20-16	W0-423-20-17	W0-423-20-18
Plating Conditions	Dispersion Number	2-5B	2-5B	2-5B	2-5B	2-5B	2-5B	2-5B
	Voltage	150	300	200	200	200	200	200
	Milliamps	80	65	70	60	50	50	50
	Time (Seconds)	120	150	150	150	150	150	150
	Coating Thickness (mils)	4.7	6.6	5.0	6.0	5.0	5.0	5.0
Sintering	Densification Press (tsi)	30	30	30	30	30	30	30
	Temperature (°F)	2910	2910	2910	2910	2910	2910	2910
	Time (hours)	2	2	2	2	2	2	2
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
	Temperature (°F)	2370	2370	2370	2370	2370	2370	2370
Silicizing	Time (hours)	8	8	8	8	8	8	8
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Weight Gain (mgs/cm ²)	3.96	3.28	1.74	21.72	1.96	3.12	
	Temperature (°F)	-	-	-	-	-	-	-
	Time (minutes)	-	-	-	-	-	-	-
Preoxidation	Atmosphere	-	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-
	Number of Cycles	36	20	18	-	-	-	-
	Oxidation Life (hours)	142	80	76	-	-	-	-
	Type of Failure	CORNER	SURFACE	CORNER	-	-	-	-
OXIDATION TEST RESULTS	Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-	-
	Number of Cycles	-	-	-	13	2	15	
	Oxidation Life (hours)	-	-	-	52	4	56	
	Type of Failure	-	-	-	EDGE	CORNER	SURFACE	
	Appearance of Coating Surface	-	-	-	Non-GLASSY	Non-GLASSY	Non-GLASSY	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 300\% Si_2$

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS				
Specimen Number			W6-434-2-1		W6-434-4-2		W6-434-6-3		W6-434-78-1		W6-434-80-2		W6-434-82-3	
Dispersion Number			2-5C-1		2-5C-1		2-5C-1		2-5C-1		2-5C-1		2-5C-1	
Voltage			200		200		200		200		200		200	
Milliamps			45		45		45		45		45		45	
Time (Seconds)			120		120		120		120		120		120	
Coating Thickness (mils)			5.5		5.5		5.5		5.4		5.4		5.4	
Densification Press (tsi)			30		30		30		30		30		30	
Temperature (°F)			2910		2910		2910		2910		2910		2910	
Time (hours)			2		2		2		2		2		2	
Atmosphere			ARGON		ARGON		ARGON		ARGON		ARGON		ARGON	
Temperature (°F)			-		-		-		-		-		-	
Time (hours)			-		-		-		-		-		-	
Atmosphere			-		-		-		-		-		-	
Weight Gain (mgs/cm ²)			-		-		-		-		-		-	
Temperature (°F)			-		-		-		-		-		-	
Time (minutes)			-		-		-		-		-		-	
Atmosphere			-		-		-		-		-		-	
Weight Gain (mgs/cm ²)			-		-		-		-		-		-	
Number of Cycles			59		59		59		-		-		-	
Oxidation Life (hours)			410		410		410		-		-		-	
Type of Failure			STILL INTACT		STILL INTACT		STILL INTACT		-		-		-	
Appearance of Coating Surface			NON-GLASSY		NON-GLASSY		NON-GLASSY		-		-		-	
Number of Cycles			-		-		-		3		5		37	
Oxidation Life (hours)			-		-		-		20		24		234	
Type of Failure			-		-		-		EDGE SURFACE		EDGE SURFACE		SURFACE	
Appearance of Coating Surface			-		-		-		NON-GLASSY		NON-GLASSY		SLIGHTLY GLASSY	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 30CrSi_2$

COATING PROCESS PARAMETERS									
Plating Conditions	Specimen Number	W6-434-8-4	W6-434-10-5	W6-434-12-6	W6-434-84-4	W6-434-86-5	W6-434-88-6		
	Dispersion Number	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1		
	Voltage	200	200	200	200	200	200		
	Milliamps	45	45	45	45	45	45		
	Time (Seconds)	120	120	120	120	120	120		
	Coating Thickness (mils)	5.5	5.5	5.5	5.3	5.3	5.3		
	Densification Press (tsi)	30	30	30	30	30	30		
	Temperature (°F)	2910	2910	2910	2910	2910	2910		
	Time (hours)	2	2	2	2	2	2		
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON		
Sintering	Temperature (°F)	2370	2370	2370	2370	2370	2370		
	Time (hours)	4	4	4	4	4	4		
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM		
Preoxidation	Weight Gain (mgs/cm²)	-	-	-	-	-	-		
	Temperature (°F)	-	-	-	-	-	-		
	Time (minutes)	-	-	-	-	-	-		
	Atmosphere	-	-	-	-	-	-		
	Weight Gain (mgs/cm²)	-	-	-	-	-	-		
	Number of Cycles	59	59	59	-	-	-		
1500°F	Oxidation Life (hours)	410	410	410	-	-	-		
	Type of Failure	STILL INTACT	STILL INTACT	STILL INTACT	-	-	-		
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-		
	Number of Cycles	-	-	-	3	11	23		
	Oxidation Life (hours)	-	-	-	20	50	116		
	Type of Failure	-	-	-	EDGE	EDGE	CORNER		
2400°F	Appearance of Coating Surface	-	-	-	NON-GLASSY	NON-GLASSY	SUBSTRY GLASSY		
	OXIDATION TEST RESULTS								

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi_2 -30Cr-Si₂

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS			
Plating Conditions	Specimen Number	W6-434-14-7	W6-434-16-8	W6-434-18-7	W6-434-90-7	W6-434-92-8	W6-434-94-9						
	Dispersion Number	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1						
	Voltage	200	200	200	200	200	200						
	Milliamps	45	45	45	45	45	45						
	Time (Seconds)	120	120	120	120	120	120						
	Coating Thickness (mils)	5.5	5.5	5.5	5.3	5.3	5.3						
	Densification Press (tsi)	30	30	30	30	30	30						
	Temperature (°F)	2910	2910	2910	2910	2910	2910						
	Time (hours)	2	2	2	2	2	2						
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON						
Sintering	Temperature (°F)	2370	2370	2370	2370	2370	2370						
	Time (hours)	8	8	8	8	8	8						
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM						
Silicomizing	Weight Gain (mgs/cm²)	-	-	-	-	-	-						
	Temperature (°F)	-	-	-	-	-	-						
	Time (minutes)	-	-	-	-	-	-						
	Atmosphere	-	-	-	-	-	-						
	Weight Gain (mgs/cm²)	-	-	-	-	-	-						
	Number of Cycles	59	59	59	-	-	-						
Preoxidation	Oxidation Life (hours)	364	410	410	-	-	-						
	Type of Failure	CORNER	STILL INTACT	STILL INTACT	-	-	-						
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-						
	Number of Cycles	-	-	-	34	7	5						
	Oxidation Life (hours)	-	-	-	228	42	26						
	Type of Failure	-	-	-	SURFACE, EDGE	EDGE	SURFACE						
2400°F	Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY						

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $\text{MoSi}_2 - 10\text{VSi}_2$, DOUBLE COATED

COATING PROCESS PARAMETERS									
Specimen Number	W6-423-12-1D	W6-423-12-2D	W6-423-12-3D	W6-423-12-4D	W6-423-12-5D	W6-423-12-6D			
	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1	2-3A-1
Dispersion Number	200	200	200	200	200	200	200	200	200
Voltage	100	100	100	100	100	100	100	100	105
Milliamps	17	16	16	16	16	16	16	16	16
Time (Seconds)	2.7	2.0	2.3	2.1	2.3	2.3	2.3	2.3	1.9
Coating Thickness (mils)	30	30	30	30	30	30	30	30	30
Densification Press (tsi)	3090	3090	3090	3090	3090	3090	3090	3090	3090
Temperature (°F)	1	1	1	1	1	1	1	1	1
Time (hours)	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Atmosphere	2370	2370	2370	2370	2370	2370	2370	2370	2370
Temperature (°F)	8	8	8	8	8	8	8	8	8
Time (hours)	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Atmosphere	3.50	3.68	3.63	3.61	2.88	2.79	2.88	2.79	2.79
Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-	-	-
Temperature (°F)	-	-	-	-	-	-	-	-	-
Time (minutes)	-	-	-	-	-	-	-	-	-
Atmosphere	-	-	-	-	-	-	-	-	-
Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-	-	-
Number of Cycles	1	1	1	1	1	1	1	1	10
Oxidation Life (hours)	2	2	2	2	2	2	2	2	48
Type of Failure	EDGE	EDGE	EDGE	EDGE	EDGE	EDGE	EDGE	EDGE	GENERAL
Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	SLIGHTLY GLASSY
Number of Cycles	-	-	-	-	-	-	-	-	-
Oxidation Life (hours)	-	-	-	-	-	-	-	-	-
Type of Failure	-	-	-	-	-	-	-	-	-
Appearance of Coating Surface	-	-	-	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2$ DOUBLE COATED

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
Plating Conditions	Specimen Number	W0-423-27-2D	W0-423-27-2D	W0-423-27-3D	W0-423-27-4D	W0-423-27-5D	W0-423-27-6D
	Dispersion Number	2-4B-5	2-4B-5	2-4B-5	2-4B-5	2-4B-5	2-4B-5
	Voltage	200	200	200	200	200	200
	Milliamps	20	20	25	20	20	25
	Time (Seconds)	30	30	30	30	30	30
	Coating Thickness (mils)	1.5	1.8	1.7	1.3	1.5	1.5
	Densification Press (tsi)	30	30	30	30	30	30
	Temperature (°F)	3090	3090	3090	3090	3090	3090
	Time (hours)	1	1	1	1	1	1
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Sintering	Temperature (°F)	2370	2370	2370	2370	2370	2370
	Time (hours)	8	8	8	8	8	8
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Weight Gain (mgs/cm ²)	0.68	2.67	1.15	2.49	1.26	3.49
Preoxidation	Temperature (°F)	-	-	-	-	-	-
	Time (minutes)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Number of Cycles	1	2	3	-	-	-
	Oxidation Life (hours)	2	4	20	-	-	-
1500°F	Type of Failure	SURFACE	SURFACE	EDGE	-	-	-
	Appearance of Coating Surface	Non-Glossy	Non-Glossy	Non-Glossy	-	-	-
	Number of Cycles	-	-	-	2	1	3
	Oxidation Life (hours)	-	-	-	4	2	20
	Type of Failure	-	-	-	SURFACE	SURFACE	GENERAL
	Appearance of Coating Surface	-	-	-	Slightly-Glossy	Slightly-Glossy	Very-Glossy
2400°F	Temperature (°F)	-	-	-	-	-	-
	Time (minutes)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Number of Cycles	1	2	3	-	-	-
	Oxidation Life (hours)	2	4	20	-	-	-
2400°F	Type of Failure	SURFACE	SURFACE	EDGE	-	-	-
	Appearance of Coating Surface	Non-Glossy	Non-Glossy	Non-Glossy	-	-	-
	Number of Cycles	-	-	-	2	1	3
	Oxidation Life (hours)	-	-	-	4	2	20
	Type of Failure	-	-	-	SURFACE	SURFACE	GENERAL
	Appearance of Coating Surface	-	-	-	Slightly-Glossy	Slightly-Glossy	Very-Glossy

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: *MoSi₂-30CrSi₂ DOUBLE COATED*

COATING PROCESS PARAMETERS		W0-423-22-1D	W0-423-22-2D	W0-423-22-3D	W0-423-22-4D	W0-423-22-5D	W0-423-22-6D
Plating Conditions	Specimen Number	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1
	Dispersion Number	200	200	200	200	200	200
Sintering	Voltage	80	80	90	90	80	95
	Milliamps	17	17	17	17	17	17
Silicizing	Time (Seconds)	1.7	1.6	2.0	3.6	1.7	1.9
	Coating Thickness (mils)	30	30	30	30	30	30
Preoxidation	Densification Press (tsi)	3090	3090	3090	3090	3090	3090
	Temperature (°F)	1	1	1	1	1	1
Oxidation Test Results	Time (hours)	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
	Atmosphere	2370	2370	2370	2370	2370	2370
1500°F	Time (hours)	8	8	8	8	8	8
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
2400°F	Weight Gain (mgs/cm ²)	1.55	5.72	1.88	5.57	2.09	3.97
	Temperature (°F)	-	-	-	-	-	-
	Time (minutes)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Number of Cycles	62	1	1	-	-	-
	Oxidation Life (hours)	404	2	2	-	-	-
	Type of Failure	STILL INTACT	GENERAL	EDGE	-	-	-
	Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	-	-	-
	Number of Cycles	-	-	-	8	1	18
	Oxidation Life (hours)	-	-	-	46	2	94
	Type of Failure	-	-	-	CORNER	SURFACE	EDGE
	Appearance of Coating Surface	-	-	-	Slightly Glassy	Non-Glassy	Slightly Glassy

COATING: MoSi₂-10VSi₂-Preoxidized

A-31

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-10VSi_2$ - PREOXIDIZED

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS											
Plating Conditions										1500 °F											
Specimen Number	W0-423-45-8	W0-423-45-9	W0-423-45-10	W0-423-45-11	W0-423-45-12	W0-423-45-13					Preoxidation	2400 °F									
Dispersion Number	2-3A-2	2-3A-2	2-3A-2	2-3A-2	2-3A-2	2-3A-2						Sintering									
Voltage	150	150	150	150	150	150						Silicizing									
Milliamps	145	150	150	150	35	50						Silicizing									
Time (Seconds)	105	105	105	105	120	120						Silicizing									
Coating Thickness (mils)	2.0	2.0	2.0	2.0	2.3	2.0						Silicizing									
Densification Press (tsi)	10	10	10	10	10	10						Silicizing									
Temperature (°F)	2910	2910	2910	2910	2910	2910						Silicizing									
Time (hours)	2	2	2	2	2	2						Silicizing									
Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON						Silicizing									
Temperature (°F)	2370	2370	2370	2370	2370	2370					Silicizing										
Time (hours)	8	8	8	8	8	8					Silicizing										
Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM					Silicizing										
Weight Gain (mgs/cm²)	2.96	5.11	5.11	5.11	1.94	3.73					Silicizing										
Temperature (°F)	2910	2910	2910	2910	2910	2910					Preoxidation										
Time (minutes)	15	15	15	15	15	15					Preoxidation										
Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR					Preoxidation										
Weight Gain (mgs/cm²)	2.07	1.90	1.99	1.99	2.86	2.23					Preoxidation										
Number of Cycles	1	1	1	1	-	-					Preoxidation										
Oxidation Life (hours)	2	2	2	2	-	-					Preoxidation										
Type of Failure	GENERAL	SURFACE	EDGE	EDGE	-	-					Preoxidation										
Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	-	-					Preoxidation										
Number of Cycles	-	-	-	-	2	40					Preoxidation										
Oxidation Life (hours)	-	-	-	-	4	320					Preoxidation										
Type of Failure	-	-	-	-	EDGE	SURFACE					Preoxidation										
Appearance of Coating Surface	-	-	-	-	-	SLIGHTLY GLASSY					Preoxidation										

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-10VSi_2$ - PREOXIDIZED

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS									
Specimen Number	W6-423-45-15	W6-423-45-16	W6-423-45-17	W6-423-45-18	W6-423-45-19	W6-423-45-20							
Dispersion Number	2-3A-2	2-3A-2	2-3A-2	2-3A-2	2-3A-2	2-3A-2							
Voltage	150	150	150	150	150	150							
Milliamps	130	35	35	35	40	35							
Time (Seconds)	105	120	120	120	120	120							
Coating Thickness (mils)	2.0	2.0	2.0	2.1	2.3	2.2							
Densification Press (tsi)	10	10	10	10	10	10							
Temperature (°F)	2910	2910	2910	2910	2910	2910							
Time (hours)	2	2	2	2	2	2							
Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON							
Temperature (°F)	2370	2370	2370	2370	2370	2370							
Time (hours)	8	8	8	8	8	8							
Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM							
Weight Gain (mgs/cm ²)	3.68	4.52	6.90	1.58	4.99	4.24							
Temperature (°F)	2910	2910	2910	2910	2910	2910							
Time (minutes)	30	30	30	30	30	30							
Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR							
Weight Gain (mgs/cm ²)	2.86	3.10	2.96	2.29	3.10	2.86							
Number of Cycles	1	1	1	-	-	-							
Oxidation Life (hours)	2	2	2	-	-	-							
Type of Failure	SURFACE	SURFACE	EDGE	-	-	-							
Appearance of Coating Surface	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY	-	-	-							
Number of Cycles	-	-	-	2	54	4							
Oxidation Life (hours)	-	-	-	4	392	24							
Type of Failure	-	-	-	EDGE, SURFACE	CORNER	SURFACE							
Appearance of Coating Surface	-	-	-	NON-GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY							

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi_2 -10VSi₂-Preoxidized

COATING PROCESS PARAMETERS				WO-423-45-22	WO-423-45-23	WO-423-45-24	WO-423-45-25	WO-423-45-26	WO-423-45-27
Plating Conditions	Specimen Number			2-3A-2	2-3A-2	2-3A-2	2-3A-2	2-3A-2	2-3A-2
	Dispersion Number			150	150	150	150	100	100
	Voltage			20	20	35	40	40	40
	Milliamps			105	120	120	120	240	240
	Time (Seconds)			2.2	2.2	2.2	2.2	2.0	2.0
Sintering	Coating Thickness (mils)			10	10	10	10	10	10
	Densification Press (tsi)			2910	2910	2910	2910	2910	2910
	Temperature (°F)			2	2	2	2	2	2
	Time (hours)			ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
	Atmosphere			2370	2370	2370	2370	2370	2370
Siliconizing	Temperature (°F)			8	8	8	8	8	8
	Time (hours)			VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Atmosphere			4.46	4.96	1.70	4.01	4.18	3.94
	Weight Gain (mgs/cm ²)			2730	2730	2730	2730	2730	2730
	Temperature (°F)			30	30	30	30	30	30
Preoxidation	Time (minutes)			AIR	AIR	AIR	AIR	AIR	AIR
	Atmosphere			3.4	2.2	2.2	2.4	2.35	2.68
	Weight Gain (mgs/cm ²)			4	4	4	-	-	-
	Number of Cycles			22	22	22	-	-	-
	Oxidation Life (hours)			SURFACE	SURFACE	SURFACE, EDGES	-	-	-
1500°F	Type of Failure			Non-Glassy	Non-Glassy	Non-Glassy	-	-	-
	Appearance of Coating Surface			-	-	-	4	3	3
	Number of Cycles			-	-	-	22	6	6
	Oxidation Life (hours)			-	-	-	EDGE	EDGE	SURFACE, CORNER
	Type of Failure			-	-	-	Slightly Glassy	Slightly Glassy	Slightly Glassy
2400°F	Appearance of Coating Surface			-	-	-	-	-	-
	Number of Cycles			-	-	-	-	-	-
	Oxidation Life (hours)			-	-	-	-	-	-
	Type of Failure			-	-	-	-	-	-
	Appearance of Coating Surface			-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi_2 -207TS₂-~~Reoxidized~~

COATING PROCESS PARAMETERS									
Plating Conditions	Specimen Number	W6-423-46-1	W6-423-46-2	W6-423-46-3	W6-423-46-4	W6-423-46-5	W6-423-46-6		
	Dispersion Number	2-48-7	2-48-7	2-48-7	2-48-7	2-48-7	2-48-7	2-48-7	2-48-7
	Voltage	150	150	150	100	100	100	100	150
	Milliamps	30	35	35	10	10	10	10	20
	Time (Seconds)	90	90	90	105	105	105	105	120
	Coating Thickness (mils)	2.0	2.1	2.2	2.2	2.3	2.3	2.3	2.2
	Densification Press (tsi)	10	10	10	10	10	10	10	10
	Temperature (°F)	2910	2910	2910	2910	2910	2910	2910	2910
	Time (hours)	2	2	2	2	2	2	2	2
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Sintering	Temperature (°F)	2370	2370	2370	2370	2370	2370	2370	2370
	Time (hours)	8	8	8	8	8	8	8	8
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Weight Gain (mgs/cm ²)	2.25	4.26	2.50	3.45	5.22	4.33	4.33	4.33
Preoxidation	Temperature (°F)	2910	2910	2910	2910	2910	2910	2910	2910
	Time (minutes)	5	5	5	5	5	5	5	5
	Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
	Weight Gain (mgs/cm ²)	2.00	1.90	2.00	2.51	2.15	2.56	2.56	2.56
1500°F	Number of Cycles	2	2	13	-	-	-	-	-
	Oxidation Life (hours)	4	4	69	-	-	-	-	-
	Type of Failure	EDGE	CORNER	CORNER, SURFACE	-	-	-	-	-
	Appearance of Coating Surface	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY	-	-	-	-	-
2400°F	Number of Cycles	-	-	-	22	8	5	5	5
	Oxidation Life (hours)	-	-	-	162	44	24	24	24
	Type of Failure	-	-	-	CORNER	CORNER, EDGE, SURFACE	SURFACE	SURFACE	SURFACE
	Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2$ -207Si₂-Preoxidized

COATING PROCESS PARAMETERS			OXIDATION TEST RESULTS											
	Specimen Number	Plating Conditions												
			W0-423-46-8	W0-423-46-9	W0-423-46-10	W0-423-46-11	W0-423-46-12	W0-423-46-13						
Plating	Dispersion Number		2-4B-7	2-4B-7	2-4B-7	2-4B-7	2-4B-7	2-4B-6						
	Voltage		150	150	150	150	150	100						
	Milliamps		65	20	35	35	35	10						
	Time (Seconds)		105	90	90	90	90	105						
	Coating Thickness (mils)		2.2	2.2	2.1	2.1	2.1	2.1						
	Densification Press (tsi)		10	10	10	10	10	10						
	Temperature (°F)		2910	2910	2910	2910	2910	2910						
	Time (hours)		2	2	2	2	2	2						
	Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON						
	Temperature (°F)		2370	2370	2370	2370	2370	2370						
Preoxidation	Time (hours)		8	8	8	8	8	8						
	Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM						
	Weight Gain (mgs/cm ²)		4.77	4.29	2.40	4.33	4.88	4.72						
	Temperature (°F)		2910	2910	2910	2910	2910	2910						
	Time (minutes)		15	15	15	15	15	15						
	Atmosphere		AIR	AIR	AIR	AIR	AIR	AIR						
	Weight Gain (mgs/cm ²)		2.61	2.12	2.32	2.15	1.94	2.30						
	Number of Cycles		3	16	4	-	-	-						
	Oxidation Life (hours)		6	89	22	-	-	-						
	Type of Failure		EDGE	SURFACE	EDGE, SURFACE	-	-	-						
2400 °F	Appearance of Coating Surface		SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY	-	-	-						
	Number of Cycles		-	-	-	5	4	6						
	Oxidation Life (hours)		-	-	-	24	22	26						
	Type of Failure		-	-	-	CORNER	PATCH	EDGE						
	Appearance of Coating Surface		-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY						
	Number of Cycles		-	-	-	-	-	-						
	Oxidation Life (hours)		-	-	-	-	-	-						
	Type of Failure		-	-	-	-	-	-						
	Appearance of Coating Surface		-	-	-	-	-	-						
	Number of Cycles		-	-	-	-	-	-						
	Oxidation Life (hours)		-	-	-	-	-	-						

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: *MoSi₂-20TiSi₂-Preoxidized*

COATING PROCESS PARAMETERS				WO-423-46-15	WO-423-46-16	WO-423-46-17	WO-423-46-18	WO-423-46-19	WO-423-46-20
Plating Conditions	Specimen Number			2-4B-7	2-4B-7	2-4B-7	2-4B-6	2-4B-6	2-4B-6
	Dispersion Number			150	150	150	100	100	150
	Voltage			20	35	30	10	10	20
	Millamps			90	90	90	105	105	120
	Time (Seconds)			2.0	2.1	2.1	2.1	2.1	2.3
Sintering	Coating Thickness (mils)			10	10	10	10	10	10
	Densification Press (tsi)			2910	2910	2910	2910	2910	2910
	Temperature (°F)			2	2	2	2	2	2
	Time (hours)			ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
	Atmosphere			2370	2370	2370	2370	2370	2370
Siliconizing	Temperature (°F)			8	8	8	8	8	8
	Time (hours)			VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Atmosphere			5.63	5.33	4.51	2.57	4.69	3.98
	Weight Gain (mgs/cm ²)			2910	2910	2910	2910	2910	2910
	Temperature (°F)			30	30	30	30	30	30
Preoxidation	Time (minutes)			AIR	AIR	AIR	AIR	AIR	AIR
	Atmosphere			2.95	2.81	2.82	2.88	2.74	2.92
	Weight Gain (mgs/cm ²)			2	4	4	-	-	-
	Number of Cycles			4	22	22	-	-	-
	Oxidation Life (hours)			CORNER	SURFACE, EDGE, CORNER	SURFACE, EDGE	-	-	-
1500 °F	Type of Failure			SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY	-	-	-
	Appearance of Coating Surface			-	-	-	4	5	24
	Number of Cycles			-	-	-	22	24	183
	Oxidation Life (hours)			-	-	-	CORNER	CORNER	SURFACE
	Type of Failure			-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHT GLASSY
2400 °F	Appearance of Coating Surface			-	-	-	-	-	-
	Number of Cycles			-	-	-	-	-	-
	Oxidation Life (hours)			-	-	-	-	-	-
	Type of Failure			-	-	-	-	-	-
	Appearance of Coating Surface			-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2$ - 20 πSi_2 - Preoxidized

COATING PROCESS PARAMETERS									
OXIDATION TEST RESULTS									
Plating Conditions	Specimen Number	W0-423-46-22	W0-423-46-23	W0-423-46-24	W0-423-46-25	W0-423-46-26	W0-423-46-27		
	Dispersion Number	2-4B-7	2-4B-7	2-4B-7	2-4B-7	2-4B-7	2-4B-7		
	Voltage	150	150	150	150	150	150		
	Milliamps	30	25	25	20	30	40		
	Time (Seconds)	90	150	150	90	90	90		
	Coating Thickness (mils)	2.2	2.2	2.2	2.2	2.2	2.3		
	Densification Press (psi)	10	10	10	10	10	10		
	Temperature (°F)	2910	2910	2910	2910	2910	2910		
	Time (hours)	2	2	2	2	2	2		
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON		
Silicizing	Temperature (°F)	2370	2370	2370	2370	2370	2370		
	Time (hours)	8	8	8	8	8	8		
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM		
	Weight Gain (mgs/cm ²)	5.31	5.82	4.76	3.7	5.67	5.27		
Preoxidation	Temperature (°F)	2730	2730	2730	2730	2730	2730		
	Time (minutes)	30	30	30	30	30	30		
	Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR		
	Weight Gain (mgs/cm ²)	0.81	1.05	2.74	2.3	2.28	2.33		
1500°F	Number of Cycles	4	4	4	-	-	-		
	Oxidation Life (hours)	22	22	22	-	-	-		
	Type of Failure	EDGE	SURFACE EDGES	EDGE	-	-	-		
	Appearance of Coating Surface	SILICIDY GLASSY	NON-GLASSY	NON-GLASSY	-	-	-		
2400°F	Number of Cycles	-	-	-	4	4	20		
	Oxidation Life (hours)	-	-	-	22	22	160		
	Type of Failure	-	-	-	-	CORNER	CORNER		
	Appearance of Coating Surface	-	-	-	SILICIDY GLASSY	SILICIDY GLASSY	SILICIDY GLASSY		

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi_2 - 3MoSi_2 -PREOXIDIZED

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS									
Specimen Number	Plating Conditions	1500°F					2400°F				
		W0-423-47-1	W0-423-47-2	W0-423-47-3	W0-423-47-4	W0-423-47-5	W0-423-47-6	W0-423-47-7	W0-423-47-8	W0-423-47-9	W0-423-47-10
Dispersion Number		2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1
Voltage		150	150	150	150	150	150	150	150	150	100
Milliamps		50	50	50	50	50	50	50	50	50	40
Time (Seconds)		120	120	120	120	120	120	120	120	120	90
Coating Thickness (mils)		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Densification Press (tsi)		10	10	10	10	10	10	10	10	10	10
Temperature (°F)		2910	2910	2910	2910	2910	2910	2910	2910	2910	2910
Time (hours)		2	2	2	2	2	2	2	2	2	2
Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Temperature (°F)		2370	2370	2370	2370	2370	2370	2370	2370	2370	2370
Time (hours)		8	8	8	8	8	8	8	8	8	8
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Weight Gain (mgs/cm ²)		3.85	3.81	3.49	4.03	4.19	4.85	4.85	4.85	4.85	4.85
Temperature (°F)		2910	2910	2910	2910	2910	2910	2910	2910	2910	2910
Time (minutes)		5	5	5	5	5	5	5	5	5	5
Atmosphere		AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
Weight Gain (mgs/cm ²)		1.09	1.20	1.18	1.23	0.88	1.18	0.88	1.18	1.18	1.18
Number of Cycles		57	1	12	-	-	-	-	-	-	-
Oxidation Life (hours)		460	2	67	-	-	-	-	-	-	-
Type of Failure		STILL INTACT	PATCH	SURFACE	-	-	-	-	-	-	-
Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY
Number of Cycles		-	-	-	-	-	-	-	-	-	-
Oxidation Life (hours)		-	-	-	-	-	-	-	-	-	-
Type of Failure		-	-	-	-	-	-	-	-	-	-
Appearance of Coating Surface		-	-	-	-	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi_2 - 30CrSi_2 - FeOxIDIZED

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS									
Plating Conditions		1500°F									
Specimen Number	W6-423-47-8	W6-423-47-9	W6-423-47-10	W6-423-47-11	W6-423-47-12	W6-423-47-13					
Dispersion Number	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1					
Voltage	150	150	100	100	100	100					
Milliamps	50	50	45	40	40	40					
Time (Seconds)	120	120	90	90	105	105					
Coating Thickness (mils)	2.1	2.2	2.1	2.0	2.0	2.0					
Densification Press (tsi)	10	10	10	10	10	10					
Temperature (°F)	2910	2910	2910	2910	2910	2910					
Time (hours)	2	2	2	2	2	2					
Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON					
Temperature (°F)	2370	2370	2370	2370	2370	2370					
Time (hours)	8	8	8	8	8	8					
Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM					
Weight Gain (mgs/cm ²)	2.63	3.44	2.63	2.69	3.72	2.95					
Temperature (°F)	2910	2910	2910	2910	2910	2910					
Time (minutes)	15	15	15	15	15	15					
Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR					
Weight Gain (mgs/cm ²)	1.38	1.21	1.63	1.72	1.58	1.53					
Number of Cycles	30	8	12	-	-	-					
Oxidation Life (hours)	209	45	67	-	-	-					
Type of Failure	PATCH	SURFACE	CORNER	-	-	-					
Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-					
Number of Cycles	-	-	-	6	8	4					
Oxidation Life (hours)	-	-	-	26	45	22					
Type of Failure	-	-	-	CORNER	CORNER	EDGE					
Appearance of Coating Surface	-	-	-	NON-GLASSY	NON-GLASSY	NON-GLASSY					

**PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS**

COATING: MoSi₂-30CrSi₂ PREOXIDIZED

COATING PROCESS PARAMETERS		W6-423-47-15	W6-423-47-16	W6-423-47-17	W6-423-47-18	W6-423-47-19	W6-423-47-20
Plating Conditions	Specimen Number	W6-423-47-15	W6-423-47-16	W6-423-47-17	W6-423-47-18	W6-423-47-19	W6-423-47-20
	Dispersion Number	2-5C-1	2-5C-3	2-5C-3	2-5C-3	2-5C-3	2-5C-3
	Voltage	150	100	100	100	100	100
	Milliamps	50	15	15	20	20	20
	Time (Seconds)	120	120	120	120	120	120
	Coating Thickness (mils)	2.1	2.2	1.9	2.0	2.0	2.0
	Densification Press (tsi)	10	10	10	10	10	10
	Temperature (°F)	2910	2910	2910	2910	2910	2910
Sintering	Time (hours)	2	2	2	2	2	2
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Silicizing	Temperature (°F)	2370	2370	2370	2370	2370	2370
	Time (hours)	8	8	8	8	8	8
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Weight Gain (mgs/cm ²)	2.45	2.38	2.30	1.97	2.37	2.04
Preoxidation	Temperature (°F)	2910	2910	2910	2910	2910	2910
	Time (minutes)	30	30	30	30	30	30
	Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR
	Weight Gain (mgs/cm ²)	1.42			1.13	1.82	1.82
	Number of Cycles	16	8	8	-	-	-
	Oxidation Life (hours)	138	45	45	-	-	-
OXIDATION TEST RESULTS	Type of Failure	EDGES	SURFACE	CORNER, EDGE	-	-	-
	Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-
	Number of Cycles	-	-	-	4	5	4
	Oxidation Life (hours)	-	-	-	22	24	22
	Type of Failure	-	-	-	CORNER	EDGE	CORNER
	Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	Non-GLASSY	SLIGHTLY GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-30CrSi_2$ - PREOXIDIZED

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
		Plating Conditions		1500°F		2400°F	
Specimen Number		W6-423-47-22	W6-423-47-23	W6-423-47-24	W6-423-47-25	W6-423-47-26	W6-423-47-27
Dispersion Number		2-5C-3	2-5C-3	2-5C-3	2-5C-3	2-5C-1	2-5C-3
Voltage		100	100	100	100	100	100
Milliamps		20	30	25	20	45	15
Time (Seconds)		120	120	120	120	120	120
Coating Thickness (mils)		2.0	2.1	2.1	2.0	2.0	2.2
Densification Press (tsi)		10	10	10	10	10	10
Temperature (°F)		2910	2910	2910	2910	2910	2910
Time (hours)		2	2	2	2	2	2
Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Temperature (°F)		2370	2370	2370	2370	2370	2370
Time (hours)		8	8	8	8	8	8
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Weight Gain (mgs/cm ²)		1.68	2.81	1.43	2.81	4.09	2.82
Temperature (°F)		2730	2730	2730	2730	2730	2730
Time (minutes)		30	30	30	30	30	30
Atmosphere		AIR	AIR	AIR	AIR	AIR	AIR
Weight Gain (mgs/cm ²)		0.35	0.98	2.21	1.27	1.34	0.61
Number of Cycles		16	25	1	-	-	-
Oxidation Life (hours)		138	185	2	-	-	-
Type of Failure		Edges	SURFACE	SURFACE	-	-	-
Appearance of Coating Surface		Non-Glassy	Non-Glassy	Non-Glassy	-	-	-
Number of Cycles		-	-	-	1	16	5
Oxidation Life (hours)		-	-	-	2	138	24
Type of Failure		-	-	-	EDGE	CORNER	CORNER
Appearance of Coating Surface		-	-	-	Non-Glassy	Slightly Glassy	Slightly Glassy

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-30C-Si_2$ - PREOXIDIZED

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS									
Specimen Number	Plating Conditions	1500 °F					2400 °F				
		W6-423-47-29	W6-423-47-30	W6-423-47-31	W6-423-47-32	W6-423-47-33	W6-423-47-34	W6-423-47-35	W6-423-47-36	W6-423-47-37	W6-423-47-38
Dispersion Number		2-5C-3	2-5C-3	2-5C-1	2-5C-1	2-5C-3	2-5C-3	2-5C-1	2-5C-3	2-5C-3	2-5C-3
Voltage		100	100	100	100	100	100	100	100	100	100
Milliamps		25	25	40	40	25	25	50	25	25	30
Time (Seconds)		120	120	120	120	120	120	120	120	120	120
Coating Thickness (mils)		2.0	1.9	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1
Densification Press (psi)		10	10	10	10	10	10	10	10	10	10
Temperature (°F)		2910	2910	2910	2910	2910	2910	2910	2910	2910	2910
Time (hours)		2	2	2	2	2	2	2	2	2	2
Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Temperature (°F)		2370	2370	2370	2370	2370	2370	2370	2370	2370	2370
Time (hours)		16	16	16	16	16	16	16	16	16	16
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Weight Gain (mgs/cm ²)		4.92	6.23	4.10	4.10	5.12	6.34	5.12	6.34	5.21	5.21
Temperature (°F)		2910	2910	2910	2910	2910	2910	2910	2910	2910	2910
Time (minutes)		5	5	5	5	5	5	5	5	5	5
Atmosphere		AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
Weight Gain (mgs/cm ²)		-	-	-	-	-	-	-	-	-	-
Number of Cycles		21	4	8	8	-	-	-	-	-	-
Oxidation Life (hours)		164	23	46	46	-	-	-	-	-	-
Type of Failure		SURFACE	CORNER, EDGE	SURFACE	SURFACE	-	-	-	-	-	-
Appearance of Coating Surface		Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	-	-	-	-	-	-
Number of Cycles		-	-	-	-	4	16	4	16	12	12
Oxidation Life (hours)		-	-	-	-	23	139	23	139	69	69
Type of Failure		-	-	-	-	-	-	-	-	-	-
Appearance of Coating Surface		-	-	-	-	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-30Cr-Si_2$ PREOXIDIZED

COATING PROCESS PARAMETERS									
Plating Conditions	Specimen Number	W0-423-47-36	W0-423-47-37	W0-423-47-38	W0-423-47-39	W0-423-47-40	W0-423-47-41		
	Dispersion Number	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1	2-5C-1		
	Voltage	100	100	100	100	150	150		
	Milliamps	30	30	30	30	50	50		
	Time (Seconds)	120	120	120	120	120	120		
	Coating Thickness (mils)	2.0	2.2	2.1	2.2	2.1	2.1		
	Densification Press (tsi)	10	10	10	10	10	10		
	Temperature (°F)	2910	2910	2910	2910	2910	2910		
	Time (hours)	2	2	2	2	2	2		
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON		
Sintering	Temperature (°F)	2370	2370	2370	2370	2370	2370		
	Time (hours)	16	16	16	16	16	16		
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM		
	Weight Gain (mgs/cm ²)	3.86	6.79	4.70	5.59	2.29	6.47		
Preoxidation	Temperature (°F)	2910	2910	2910	2910	2910	2910		
	Time (minutes)	15	15	15	15	15	15		
	Atmosphere	AIR	AIR	AIR	AIR	AIR	AIR		
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-		
OXIDATION TEST RESULTS	Number of Cycles	1	1	8	-	-	-		
	Oxidation Life (hours)	2	2	46	-	-	-		
	Type of Failure	EDGE	CORNER	SURFACE	-	-	-		
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-		
	Number of Cycles	-	-	-	16	4	9		
	Oxidation Life (hours)	-	-	-	139	23	48		
	Type of Failure	-	-	-	SURFACE	CORNER	SURFACE GENERAL		
	Appearance of Coating Surface	-	-	-	NON-GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY		

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: *Mo-154Ti-Si*

COATING PROCESS PARAMETERS						OXIDATION TEST RESULTS					
Plating Conditions	Specimen Number	W0-423-48-1	W0-423-48-2	W0-423-48-3	W0-423-48-4	-	-	-	-	-	-
	Dispersion Number	EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1	-	-	-	-	-	-
	Voltage	150	150	150	150	-	-	-	-	-	-
	Milliamps	75	75	75	75	-	-	-	-	-	-
	Time (Seconds)	60	60	60	60	-	-	-	-	-	-
	Coating Thickness (mils)	2.0	2.0	2.0	2.0	-	-	-	-	-	-
	Densification Press (tsi)	30	30	30	30	-	-	-	-	-	-
	Temperature (°F)	3630	3630	3630	3630	-	-	-	-	-	-
	Time (hours)	3	3	3	3	-	-	-	-	-	-
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	-	-	-	-	-	-
Sintering	Temperature (°F)	2370	2370	2370	2370	-	-	-	-	-	-
	Time (hours)	16	16	16	16	-	-	-	-	-	-
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	-	-	-	-	-	-
	Weight Gain (mgs/cm²)	-	-	-	-	-	-	-	-	-	-
Silicizing	Temperature (°F)	-	-	-	-	-	-	-	-	-	-
	Time (minutes)	-	-	-	-	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-	-	-	-	-
	Weight Gain (mgs/cm²)	-	-	-	-	-	-	-	-	-	-
Preoxidation	Number of Cycles	15	17	14	61	-	-	-	-	-	-
	Oxidation Life (hours)	70	88	68	446	-	-	-	-	-	-
	Type of Failure	CORNER	SURFACE	SURFACE	STILL INTACT	-	-	-	-	-	-
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-	-	-	-
1500 °F	Number of Cycles	-	-	-	-	-	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-	-	-	-	-	-
	Type of Failure	-	-	-	-	-	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	-	-	-	-	-	-	-
2400 °F	Number of Cycles	-	-	-	-	-	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-	-	-	-	-	-
	Type of Failure	-	-	-	-	-	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	-	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: Mo-15.4 Ti-5i

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS							
Specimen Number	Plating Conditions	1500°F				2400°F			
		Mo-423-48-5	Mo-423-48-6	Mo-423-48-7	Mo-423-48-8	Mo-423-48-5	Mo-423-48-6	Mo-423-48-7	Mo-423-48-8
Dispersion Number		EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1	EP-7-8-48-1
Voltage		150	150	150	150	150	150	150	150
Milliamps		80	75	7	70	80	75	7	70
Time (Seconds)		60	60	60	60	60	60	60	60
Coating Thickness (mils)		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Densification Press (tsi)		30	30	30	30	30	30	30	30
Temperature (°F)		3630	3630	3630	3630	3630	3630	3630	3630
Time (hours)		3	3	3	3	3	3	3	3
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Temperature (°F)		2370	2370	2370	2370	2370	2370	2370	2370
Time (hours)		16	16	16	16	16	16	16	16
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Weight Gain (mgs/cm ²)		-	-	-	-	-	-	-	-
Temperature (°F)		-	-	-	-	-	-	-	-
Time (minutes)		-	-	-	-	-	-	-	-
Atmosphere		-	-	-	-	-	-	-	-
Weight Gain (mgs/cm ²)		-	-	-	-	-	-	-	-
Number of Cycles		-	-	-	-	-	-	-	-
Oxidation Life (hours)		-	-	-	-	-	-	-	-
Type of Failure		-	-	-	-	-	-	-	-
Appearance of Coating Surface		-	-	-	-	-	-	-	-
Number of Cycles		2	19	1	2	2	19	1	2
Oxidation Life (hours)		4	92	2	4	4	92	2	4
Type of Failure		EDGE	SURFACE	SURFACE	SURFACE	EDGE	SURFACE	SURFACE	SURFACE, EDGE
Appearance of Coating Surface		Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: Mo-15.4Ti-Si

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS					
Specimen Number		W0-423-48-9	W0-423-48-10	W0-423-48-11	W0-423-48-12	W0-423-48-13	W0-423-48-14	Plating Conditions		1500°F		2400°F			
Dispersion Number		EP-78-48-1	EP-78-48-1	EP-78-48-1	EP-78-48-1	EP-78-48-1	EP-78-48-1								
Voltage		150	150	150	150	150	150								
Milliamps		75	70	80	65	80	75								
Time (Seconds)		60	60	60	60	60	90								
Coating Thickness (mils)		2.0	2.1	2.1	2.0	2.0	2.2								
Densification Press (psi)		30	30	30	30	30	30								
Temperature (°F)		2910	2910	2910	2910	2910	2910								
Time (hours)		3	3	3	3	3	3								
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM								
Temperature (°F)		2370	2370	2370	2370	2370	2370								
Time (hours)		16	16	16	16	16	16								
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM								
Weight Gain (mgs/cm²)		11.83	18.16	6.82	13.59	18.84	12.94								
Temperature (°F)		-	-	-	-	-	-								
Time (minutes)		-	-	-	-	-	-								
Atmosphere		-	-	-	-	-	-								
Weight Gain (mgs/cm²)		-	-	-	-	-	-								
Number of Cycles		4	1	4	-	-	-								
Oxidation Life (hours)		23	2	23	-	-	-								
Type of Failure		SURFACE	SURFACE	SURFACE	-	-	-								
Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-								
Number of Cycles		-	-	-	3	2	2								
Oxidation Life (hours)		-	-	-	6	4	4								
Type of Failure		-	-	-	EDGE	EDGE	EDGE								
Appearance of Coating Surface		-	-	-	NON-GLASSY	NON-GLASSY	NON-GLASSY								

COATING: CrSi₂-20VSi₂

A-48

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-15CrSi_2-15VSi_2$

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS			
Plating Conditions		W6-423-58-1	W6-423-58-2	W6-423-58-3	W6-423-58-4	W6-423-58-5	W6-423-58-6						
Dispersion Number		W6-423-58A	W6-423-58A	W6-423-58A	W6-423-58A	W6-423-58A	W6-423-58A						
Voltage		125"	125"	125"	125"	125"	125"						
Milliamps		25	25	25	25	25	25						
Time (Seconds)		60	60	75	60	60	75						
Coating Thickness (mils)		2.0	2.0	2.0	2.0	2.0	2.0						
Densification Press (tsi)		10	10	10	10	10	10						
Temperature (°F)		2910	2910	2910	2910	2910	2910						
Time (hours)		2	2	2	2	2	2						
Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON						
Temperature (°F)		2370	2370	2370	2370	2370	2370						
Time (hours)		8	8	8	8	8	8						
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM						
Weight Gain (mgs/cm ²)		2.11	3.52	3.64	2.04	3.64	3.50						
Temperature (°F)		-	-	-	-	-	-						
Time (minutes)		-	-	-	-	-	-						
Atmosphere		-	-	-	-	-	-						
Weight Gain (mgs/cm ²)		-	-	-	-	-	-						
Number of Cycles		9	19	11	-	-	-						
Oxidation Life (hours)		46	156	64	-	-	-						
Type of Failure		SURFACE, EDGE	CORNER	EDGE	-	-	-						
Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-						
Number of Cycles		-	-	-	15"	11	10						
Oxidation Life (hours)		-	-	-	86	64	48						
Type of Failure		-	-	-	SURFACE	SURFACE	EDGE						
Appearance of Coating Surface		-	-	-	SLIGHTLY-GLASSY	SLIGHTLY-GLASSY	SLIGHTLY-GLASSY						

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: 35MoSi_2 - 35WSi_2 - 15TiSi_2 - 15VSi_2

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS											
Specimen Number	Plating Conditions	1500 °F											
		W0-423-74-7	W0-423-74-8	W0-423-74-9	W0-423-74-10	W0-423-74-11	W0-423-74-12	2400 °F					
Dispersion Number		EP-423-66	EP-423-66	EP-423-66	EP-423-66	EP-423-66	EP-423-66						
Voltage		200	200	200	200	200	200						
Milliamps		35	60	65	60	60	70						
Time (Seconds)		165	165	180	210	240	300						
Coating Thickness (mils)		5.5	5.5	5.0	5.0	5.0	5.5						
Densification Press (tsi)		10	10	10	10	10	10						
Temperature (°F)		2910	2910	2910	2910	2910	2910						
Time (hours)		1	1	1	1	1	1						
Atmosphere	Sintering	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON						
Temperature (°F)	Silicizing	2370	2370	2370	2370	2370	2370						
Time (hours)		8	8	8	8	8	8						
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM						
Weight Gain (mgs/cm ²)		5.03	3.42	3.96	4.05	2.75	4.76						
Temperature (°F)	Preoxidation	-	-	-	-	-	-						
Time (minutes)		-	-	-	-	-	-						
Atmosphere		-	-	-	-	-	-						
Weight Gain (mgs/cm ²)		-	-	-	-	-	-						
Number of Cycles		8	5	5	-	-	-						
Oxidation Life (hours)		44	24	24	-	-	-						
Type of Failure		SURFACE, EDGE	EDGE	SURFACE, EDGE	-	-	-						
Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-						
Number of Cycles		-	-	-	2	2	2						
Oxidation Life (hours)		-	-	-	4	4	4						
Type of Failure		-	-	-	SURFACE, EDGE	EDGE	EDGE						
Appearance of Coating Surface		-	-	-	NON-GLASSY	SLIGHTLY GLASSY	NON-GLASSY						

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $33.6\text{MoSi}_2-27.6\text{CrSi}_2-18.7\text{TiSi}_2-19.1\text{VSi}_2$

COATING PROCESS PARAMETERS		Specimen Number	W0-423-82-19	W0-423-82-20	W0-423-82-31	W0-423-82-24	W0-423-82-32	W0-423-82-33
COATING PROCESS PARAMETERS	Plating Conditions	Dispersion Number	1-2-3-4A	1-2-3-4A	1-2-3-4A	1-2-3-4A	1-2-3-4A	1-2-3-4A
		Voltage	200	200	200	200	200	200
		Milliamps	60	60	85	105	85	85
		Time (Seconds)	125	125	300	135	360	360
		Coating Thickness (mils)	5.5	5.5	4.0	5.0	4.0	4.3
	Sintering	Densification Press (tsi)	10	10	10	10	10	10
		Temperature (°F)	2910	2910	2910	2910	2910	2910
		Time (hours)	1	1	1	1	1	1
		Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
		Temperature (°F)	2370	2370	2370	2370	2370	2370
OXIDATION TEST RESULTS	Siliconizing	Time (hours)	8	8	8	8	8	8
		Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
		Weight Gain (mgs/cm ²)	3.56	3.17	2.80	0.02	0.68	3.02
		Temperature (°F)	-	-	-	-	-	-
		Time (minutes)	-	-	-	-	-	-
	Preoxidation	Atmosphere	-	-	-	-	-	-
		Weight Gain (mgs/cm ²)	-	-	-	-	-	-
		Number of Cycles	7	12	11	-	-	-
		Oxidation Life (hours)	28	52	36	-	-	-
		Type of Failure	EDGE	SURFACE, EDGE	SURFACE, EDGE	-	-	-
OXIDATION TEST RESULTS	1500 °F	Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	-	-	-
		Number of Cycles	-	-	-	2	1	2
		Oxidation Life (hours)	-	-	-	4	2	4
		Type of Failure	-	-	-	EDGE	EDGES	SURFACE
		Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	Non-GLASSY	SLIGHTLY GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 30\%Si_2 / VS_2$

DATA IN PARENTHESIS REFER TO VS_2

COATING PROCESS PARAMETERS										OXIDATION TEST RESULTS									
Specimen Number		W0-423-49-1		W0-423-49-2		W0-423-49-3		W0-423-49-4		W0-423-49-5		W0-423-49-6							
Dispersion Number		(423-49-3) 2-5C-1 (150) 150		(423-49-3) 2-5C-1 (150) 150		(423-49-3) 2-5C-1 (150) 150		(423-49-3) 2-5C-1 (150) 150		(423-49-3) 2-5C-1 (150) 150		(423-49-3) 2-5C-1 (150) 150							
Voltage		(30) 55 (120) 180 (1.0) 3.0 (0) 10		(35) 55 180 (1.0) 3.0 (0) 10		(30) 55 180 (1.0) 3.0 (0) 10		(35) 55 180 (1.0) 3.0 (0) 10		(30) 55 180 (1.0) 3.0 (0) 10		(35) 55 180 (1.0) 3.0 (0) 10							
Milliamps		(30) 55 (120) 180 (1.0) 3.0 (0) 10		(35) 55 180 (1.0) 3.0 (0) 10		(30) 55 180 (1.0) 3.0 (0) 10		(35) 55 180 (1.0) 3.0 (0) 10		(30) 55 180 (1.0) 3.0 (0) 10		(35) 55 180 (1.0) 3.0 (0) 10							
Time (Seconds)		(120) 180 (1.0) 3.0 (0) 10		(120) 180 (1.0) 3.0 (0) 10		(120) 180 (1.0) 3.0 (0) 10		(120) 180 (1.0) 3.0 (0) 10		(120) 180 (1.0) 3.0 (0) 10		(120) 180 (1.0) 3.0 (0) 10							
Coating Thickness (mils)		(1.0) 3.0 (0) 10		(1.0) 3.0 (0) 10		(1.0) 3.0 (0) 10		(1.0) 3.0 (0) 10		(1.0) 3.0 (0) 10		(1.0) 3.0 (0) 10							
Densification Press (tsi)		(0) 10 (2910) 2910 (11) 1 (ARGON) ARGON		(0) 10 (2910) 2910 (11) 1 (ARGON) ARGON		(0) 10 (2910) 2910 (11) 1 (ARGON) ARGON		(0) 10 (2910) 2910 (11) 1 (ARGON) ARGON		(0) 10 (2910) 2910 (11) 1 (ARGON) ARGON		(0) 10 (2910) 2910 (11) 1 (ARGON) ARGON							
Temperature (°F)		(2910) 2910 (11) 1 (ARGON) ARGON		(2910) 2910 (11) 1 (ARGON) ARGON		(2910) 2910 (11) 1 (ARGON) ARGON		(2910) 2910 (11) 1 (ARGON) ARGON		(2910) 2910 (11) 1 (ARGON) ARGON		(2910) 2910 (11) 1 (ARGON) ARGON							
Time (hours)		(1) 1 (ARGON) ARGON		(1) 1 (ARGON) ARGON		(1) 1 (ARGON) ARGON		(1) 1 (ARGON) ARGON		(1) 1 (ARGON) ARGON		(1) 1 (ARGON) ARGON							
Atmosphere		(ARGON) ARGON		(ARGON) ARGON		(ARGON) ARGON		(ARGON) ARGON		(ARGON) ARGON		(ARGON) ARGON							
Temperature (°F)		2370		2370		2370		2370		2370		2370							
Time (hours)		8		8		8		8		8		8							
Atmosphere		VACUUM		VACUUM		VACUUM		VACUUM		VACUUM		VACUUM							
Weight Gain (mgs/cm²)		2.51		2.27		2.35		3.03		3.92		3.82							
Temperature (°F)		-		-		-		-		-		-							
Time (minutes)		-		-		-		-		-		-							
Atmosphere		-		-		-		-		-		-							
Weight Gain (mgs/cm²)		-		-		-		-		-		-							
Number of Cycles		44		44		24		-		-		-							
Oxidation Life (hours)		399+		399+		252		-		-		-							
Type of Failure		STILL INTACT		STILL INTACT		PATCH		-		-		-							
Appearance of Coating Surface		Non-Glassy		Non-Glassy		Non-Glassy		-		-		-							
Number of Cycles		-		-		-		7		12		7							
Oxidation Life (hours)		-		-		-		90		138		90							
Type of Failure		-		-		-		GENERAL		PATCH		PATCH							
Appearance of Coating Surface		-		-		-		Non-Glassy		Non-Glassy		Non-Glassy							

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20CoSi_2/VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS		W0-423-59-1	W0-423-59-2	W0-423-59-3	W0-423-59-4	W0-423-59-5	W0-423-59-6
Plating Conditions	Specimen Number	(423-49-3) EP-423-57-1	(423-49-3) EP-423-57-1	(423-49-3) EP-423-57-1	(423-49-3) EP-423-57-1	(423-49-3) EP-423-57-1	(423-49-3) EP-423-57-1
	Dispersion Number	(150)	(150)	(150)	(150)	(150)	(150)
Plating Conditions	Voltage	150	150	150	150	150	150
	Milliamps	(40)	(40)	(45)	(45)	(45)	(45)
Plating Conditions	Time (Seconds)	120	120	120	120	120	120
	Coating Thickness (mils)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)
Plating Conditions	Densification Press (psi)	20	20	20	20	20	20
		(0)	(0)	(0)	(0)	(0)	(0)
Sintering	Temperature ($^{\circ}F$)	2910	2910	2910	2910	2910	2910
	Time (hours)	(1)	(1)	(1)	(1)	(1)	(1)
Sintering	Atmosphere	(ARGON)	(ARGON)	(ARGON)	(ARGON)	(ARGON)	(ARGON)
		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Silicomizing	Temperature ($^{\circ}F$)	2370	2370	2370	2370	2370	2370
	Time (hours)	8	8	8	8	8	8
Silicomizing	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Preoxidation	Weight Gain (mgs/cm ²)	3.57	2.18	3.70	2.22	2.15	3.77
	Temperature ($^{\circ}F$)	-	-	-	-	-	-
Preoxidation	Time (minutes)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
Preoxidation	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
1500 $^{\circ}F$	Number of Cycles	51	35	51	-	-	-
	Oxidation Life (hours)	406+	244	406+	-	-	-
1500 $^{\circ}F$	Type of Failure	STILL INTACT	CORNER	STILL INTACT	-	-	-
	Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-
2400 $^{\circ}F$	Number of Cycles	-	-	-	10	35	21
	Oxidation Life (hours)	-	-	-	48	244	160
2400 $^{\circ}F$	Type of Failure	-	-	-	FAITH	CORNER	SURFACE
	Appearance of Coating Surface	-	-	-	SLIGHTLY GLASSY	SLIGHTLY GLASSY	SLIGHTLY GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2 - 30CrSi_2 / VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
Plating Conditions	Specimen Number	W0-423-59-8	W0-423-59-9	W0-423-59-10			
	Dispersion Number	(423-49-3) W0-423-57-1	(423-49-3) W0-423-57-1	(423-49-3) W0-423-57-1			
	Voltage	(150) 150	(150) 150	(150) 150			
	Milliamps	(40) 40	(45) 45	(35) 40			
	Time (Seconds)	(120) 120	(120) 120	(120) 120			
	Coating Thickness (mils)	(1.0) 3.2	(1.0) 2.6	(1.0) 2.0			
	Densification Press (tsi)	(0) 10	(0) 10	(0) 10			
	Temperature (°F)	(2910) 2910	(2910) 2910	(2910) 2910			
	Time (hours)	(1) 1	(1) 1	(1) 1			
	Atmosphere	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON			
Silicizing	Temperature (°F)	2370	2370	2370			
	Time (hours)	8	8	8			
	Atmosphere	VACUUM	VACUUM	VACUUM			
Preoxidation	Weight Gain (mgs/cm ²)	4.26	2.38	2.31			
	Temperature (°F)	2910	2910	2910			
	Time (minutes)	5	5	5			
	Atmosphere	AIR	AIR	AIR			
	Weight Gain (mgs/cm ²)	-	-	-			
1500°F	Number of Cycles						
	Oxidation Life (hours)						
	Type of Failure						
	Appearance of Coating Surface						
	Number of Cycles	21	12	45			
	Oxidation Life (hours)	160	366	66			
2400°F	Type of Failure	CORNER	SURFACE	EDGE			
	Appearance of Coating Surface	SUMMARY GLASSY	SUMMARY GLASSY	VERY GLASSY			

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-207Si_2/15Si_2$

DATA IN PARENTHESIS REFER TO VS_1

COATING PROCESS PARAMETERS		OXIDATION TEST RESULTS									
Specimen Number	Plating Conditions	1500 °F									
		2400 °F									
Specimen Number		W0-423-70-2	W0-423-70-4	W0-423-70-6	W0-423-70-8	W0-423-70-9	W0-423-70-11				
Dispersion Number		(EP-423-61) EP-423-64	(EP-423-61) EP-423-64	(EP-423-61) EP-423-64	(EP-423-61) EP-423-64	(EP-423-61) EP-423-64	(EP-423-61) EP-423-64				
Voltage		200 (100)	200 (100)	200 (100)	200 (100)	200 (100)	200 (100)				
Milliamps		40 (35)	45 (37)	60 (37)	75 (39)	65 (39)	70 (37)				
Time (Seconds)		75 (17)	90 (17)	90 (17)	120 (17)	120 (17)	150 (17)				
Coating Thickness (mils)		4.3 (1.0)	5.0 (1.0)	3.4 (1.0)	4.3 (1.0)	4.5 (1.0)	4.3 (1.0)				
Densification Press (psi)		10 (0)	10 (0)	10 (0)	10 (0)	10 (0)	10 (0)				
Temperature (°F)		2910 (1)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	2910 (1)				
Time (hours)		1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)				
Atmosphere		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON				
Temperature (°F)		2370	2370	2370	2370	2370	2370				
Time (hours)		16	16	16	16	16	16				
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM				
Weight Gain (mgs/cm ²)		4.22	3.25	3.39	4.41	3.30	2.54				
Temperature (°F)		-	-	-	-	-	-				
Time (minutes)		-	-	-	-	-	-				
Atmosphere		-	-	-	-	-	-				
Weight Gain (mgs/cm ²)		-	-	-	-	-	-				
Number of Cycles		191	28	56	-	-	-				
Oxidation Life (hours)		1350	208	400	-	-	-				
Type of Failure		STILL INTACT	EDGE	STILL INTACT	-	-	-				
Appearance of Coating Surface		Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-				
Number of Cycles		-	-	-	56	92	56				
Oxidation Life (hours)		-	-	-	400	682	400				
Type of Failure		-	-	-	STILL INTACT	PATCH	STILL INTACT				
Appearance of Coating Surface		-	-	-	Non-GLASSY	Non-GLASSY	Non-GLASSY				

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2/VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS		WO-423-72-13	WO-423-72-14	WO-423-72-15	WO-423-72-5	WO-423-72-11	WO-423-72-12
Plating Conditions	Specimen Number	(EP-423-61) EP-423-64	(EP-423-61) EP-423-64	(EP-423-61) EP-423-64	(EP-423-61) EP-423-63	(EP-423-61) EP-423-64	(EP-423-61) EP-423-64
	Dispersion Number	(100) 200	(100) 200	(100) 200	(100) 200	(100) 200	(100) 200
Sintering	Voltage	(57) 42	(63) 37	(64) 37	(53) 32	(57) 35	(57) 37
	Milliamps	(100) 45	(100) 45	(100) 45	(100) 90	(100) 45	(100) 45
Silicizing	Time (Seconds)	(3.0) 3.3	(3.0) 3.0	(3.0) 3.0	(2.9) 1.8	(3.0) 3.5	(3.0) 3.5
	Coating Thickness (mils)	(9) 10	(9) 10	(9) 10	(9) 10	(9) 10	(9) 10
Preoxidation	Densification Press (psi)	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910
	Temperature (°F)	(1) 1	(1) 1	(1) 1	(1) 1	(1) 1	(1) 1
1500°F	Time (hours)	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON
	Atmosphere	2370	2370	2370	2370	2370	2370
2400°F	Temperature (°F)	16	16	16	16	16	16
	Time (hours)	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
OXIDATION TEST RESULTS	Atmosphere	2.14	3.15	3.29	2.09	3.34	2.43
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Temperature (°F)	-	-	-	-	-	-
	Time (minutes)	-	-	-	-	-	-
	Atmosphere	-	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-
	Number of Cycles	188	51	11	-	-	-
	Oxidation Life (hours)	1398	446	114	-	-	-
	Type of Failure	STILL INTACT	STILL INTACT	EDGE	-	-	-
	Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	-	-	-
	Number of Cycles	-	-	-	108	51	27
	Oxidation Life (hours)	-	-	-	824	446	258
	Type of Failure	-	-	-	PATCH	STILL INTACT	CORNER
	Appearance of Coating Surface	-	-	-	Non-GLASSY	Non-GLASSY	Non-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: MoSi₂-40G.Si₂/KSi₂

DATA IN PARENTHESIS REFER TO VS₁

COATING PROCESS PARAMETERS								
Plating Conditions	Specimen Number	W0-423-76-1 (EP-423-61) EP-423-65 (100)	W0-423-76-4 (EP-423-61) EP-423-65 (100)	W0-423-76-3 (EP-423-61) EP-423-65 (100)	W0-423-76-5 (EP-423-61) EP-423-65 (100)	W0-423-76-6 (EP-423-61) EP-423-65 (100)	W0-423-76-24 (EP-423-61) EP-423-65 (100)	
	Dispersion Number	175 (45)	175 (40)	175 (42)	175 (37)	175 (39)	175 (44)	
	Voltage	75 (17)	70 (17)	75 (17)	65 (17)	65 (17)	75 (17)	
	Milliamps	120 (1.0)	120 (1.0)	120 (1.0)	120 (1.0)	120 (1.0)	120 (1.0)	
	Coating Thickness (mils)	5.5 (0)	5.5 (0)	5.5 (0)	5.5 (0)	5.5 (0)	5.5 (0)	
	Densification Press (tsi)	10 (2910)	10 (2910)	10 (2910)	10 (2910)	10 (2910)	10 (2910)	
	Temperature (°F)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	
	Time (hours)	1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)	
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	
	Temperature (°F)	2280	2280	2280	2280	2280	2280	
Sintering	Time (hours)	8	8	8	8	8	8	
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	
	Weight Gain (mgs/cm ²)	1.09	1.21	0.97	0.70	1.45	1.36	
	Temperature (°F)	-	-	-	-	-	-	
	Time (minutes)	-	-	-	-	-	-	
	Atmosphere	-	-	-	-	-	-	
	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	
	Number of Cycles	28	28	10	-	-	-	
	Oxidation Life (hours)	400	400	66	-	-	-	
	Type of Failure	STILL INTACT	STILL INTACT	EDGE	-	-	-	
1500° F	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	-	-	-	
	Number of Cycles	-	-	-	28	2	18	
	Oxidation Life (hours)	-	-	-	400	18	162	
	Type of Failure	-	-	-	STILL INTACT	CORNER	CORNER	
	Appearance of Coating Surface	-	-	-	NON-GLASSY	SLIGHTLY GLASSY	NON-GLASSY	
	2400° F	Appearance of Coating Surface	-	-	-	-	-	-
		Number of Cycles	-	-	-	-	-	-
		Oxidation Life (hours)	-	-	-	-	-	-
		Type of Failure	-	-	-	-	-	-
		Appearance of Coating Surface	-	-	-	-	-	-
Number of Cycles		-	-	-	-	-	-	
Oxidation Life (hours)		-	-	-	-	-	-	
Type of Failure		-	-	-	-	-	-	
Appearance of Coating Surface		-	-	-	-	-	-	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-40C-Si_2/VS_{12}$

DATA IN PARENTHESIS REFER TO VS_{12}

COATING PROCESS PARAMETERS		Specimen Number	WO-423-78-9	WO-423-78-11	WO-423-78-12	WO-423-78-13	WO-423-78-14	WO-423-78-16
Plating Conditions	Dispersion Number	(EP-423-62)	(EP-423-62)	(EP-423-62)	(EP-423-62)	(EP-423-62)	(EP-423-62)	(EP-423-62)
		EP-423-65	EP-423-65	EP-423-65	EP-423-65	EP-423-65	EP-423-65	EP-423-65
Plating Conditions	Voltage	(100)	(100)	(100)	(100)	(100)	(100)	(100)
		175	175	175	175	175	175	175
Plating Conditions	Milliamps	(45)	(47)	(46)	(50)	(51)	(51)	(47)
		95	100	95	95	95	95	100
Plating Conditions	Time (Seconds)	(70)	(90)	(90)	(90)	(90)	(90)	(95)
		120	135	135	135	135	135	180
Plating Conditions	Coating Thickness (mils)	(2.4)	(3.1)	(3.0)	(3.0)	(2.9)	(2.9)	(3.0)
		2.8	3.0	3.0	3.0	2.5	2.5	2.5
Plating Conditions	Densification Press (tsi)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		10	10	10	10	10	10	10
Sintering	Temperature ($^{\circ}F$)	(2910)	(2910)	(2910)	(2910)	(2910)	(2910)	(2910)
		2910	2910	2910	2910	2910	2910	2910
Sintering	Time (hours)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		1	1	1	1	1	1	1
Sintering	Atmosphere	(ARGON)	(ARGON)	(ARGON)	(ARGON)	(ARGON)	(ARGON)	(ARGON)
		ARGON	ARGON	ARGON	ARGON	ARGON	ARGON	ARGON
Silicizing	Temperature ($^{\circ}F$)	2370	2370	2370	2370	2370	2370	2370
		8	8	8	8	8	8	8
Silicizing	Time (hours)	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
		0.60	0.64	0.55	0.77	1.14	1.43	1.43
Preoxidation	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-
		-	-	-	-	-	-	-
Preoxidation	Temperature ($^{\circ}F$)	-	-	-	-	-	-	-
		-	-	-	-	-	-	-
Preoxidation	Time (minutes)	-	-	-	-	-	-	-
		-	-	-	-	-	-	-
Preoxidation	Atmosphere	-	-	-	-	-	-	-
		-	-	-	-	-	-	-
Preoxidation	Weight Gain (mgs/cm ²)	-	-	-	-	-	-	-
		-	-	-	-	-	-	-
1500 $^{\circ}F$	Number of Cycles	36	36	60	-	-	-	-
		310	310	414	-	-	-	-
1500 $^{\circ}F$	Oxidation Life (hours)	EDGE	CORNER	STILL INTACT	-	-	-	-
		Non-Glassy	Non-Glassy	Non-Glassy	-	-	-	-
2400 $^{\circ}F$	Appearance of Coating Surface	-	-	-	-	-	-	-
		-	-	-	-	-	-	-
2400 $^{\circ}F$	Number of Cycles	-	-	-	56	36	56	56
		-	-	-	406	310	406	406
2400 $^{\circ}F$	Oxidation Life (hours)	-	-	-	STILL INTACT	EDGE	STILL INTACT	STILL INTACT
		-	-	-	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy
2400 $^{\circ}F$	Type of Failure	-	-	-	-	-	-	-
		-	-	-	-	-	-	-
2400 $^{\circ}F$	Appearance of Coating Surface	-	-	-	-	-	-	-
		-	-	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2/0.5VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS		Specimen Number				
COATING TEST RESULTS	1500°F	Plating Conditions				
		W0-423-84-1	W0-423-84-8	W0-423-84-18	W0-423-84-23	W0-423-84-24
Preoxidation	Specimen Number	(38) 2-4A	(38) 2-4A	(38) 2-4A	(38) 2-4A	(38) 2-4A
	Dispersion Number	(100) 200	(100) 200	(100) 200	(100) 200	(100) 200
	Voltage	(40) 105	(35) 100	(35) 100	(35) 100	(35) 100
	Milliamps	(20) 120	(20) 120	(20) 120	(20) 120	(20) 120
	Time (Seconds)	(10) 4.4	(10) 4.0	(10) 4.2	(10) 4.0	(10) 4.0
	Coating Thickness (mils)	(10) 10	(10) 10	(10) 10	(10) 10	(10) 10
	Densification Press (psi)	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910
	Temperature (°F)	(1) 1	(1) 1	(1) 1	(1) 1	(1) 1
	Time (hours)	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON
	Atmosphere	2370	2370	2370	2370	2370
Oxidation	Temperature (°F)	8	8	8	8	8
	Time (hours)	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Atmosphere	1.64	0.34	1.05	1.57	1.09
	Weight Gain (mgs/cm ²)	-	-	-	-	-
	Temperature (°F)	-	-	-	-	-
	Time (minutes)	-	-	-	-	-
	Atmosphere	-	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-	-
	Number of Cycles	90	7	7	12	7
	Oxidation Life (hours)	626	28	28	52	28
OXIDATION TEST RESULTS	Type of Failure	Still Intact	CORNER	EDGE	CORNER	SURFACE
	Appearance of Coating Surface	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy	Non-Glassy
	Number of Cycles	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-
	Type of Failure	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2/0.5VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS		Plating Conditions			
Specimen Number		W0-423-84-25	W0-423-84-28	W0-423-84-29	W0-423-84-30
Dispersion Number		(3-B) 2-4A (100)	(3-B) 2-4A (100)	(3-B) 2-4A (100)	(3-B) 2-4A (100)
Voltage		100 (35)	100 (35)	100 (35)	100 (35)
Milliamps		45 (20)	45 (20)	45 (20)	45 (20)
Time (Seconds)		150 (1.0)	150 (1.0)	150 (1.0)	150 (1.0)
Coating Thickness (mils)		4.0 (0)	4.0 (0)	4.0 (0)	4.0 (0)
Densification Press (tsi)		10 (2910)	10 (2910)	10 (2910)	10 (2910)
Temperature (°F)		2910 (1)	2910 (1)	2910 (1)	2910 (1)
Time (hours)		1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)
Atmosphere		ARGON	ARGON	ARGON	ARGON
Temperature (°F)		2370	2370	2370	2370
Time (hours)		8	8	8	8
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM
Weight Gain (mgs/cm ²)		0.86	1.73	1.52	1.31
Temperature (°F)		-	-	-	-
Time (minutes)		-	-	-	-
Atmosphere		-	-	-	-
Weight Gain (mgs/cm ²)		-	-	-	-
Number of Cycles		7	7	17	7
Oxidation Life (hours)		28	28	124	28
Type of Failure		SURFACE	EDGE	CORNER, EDGE	SURFACE
Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY
Number of Cycles		-	-	-	-
Oxidation Life (hours)		-	-	-	-
Type of Failure		-	-	-	-
Appearance of Coating Surface		-	-	-	-
OXIDATION TEST RESULTS		1500°F			
Temperature (°F)		1500	1500	1500	1500
Time (hours)		28	28	124	28
Type of Failure		SURFACE	EDGE	CORNER, EDGE	SURFACE
Appearance of Coating Surface		NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY
Number of Cycles		-	-	-	-
Oxidation Life (hours)		-	-	-	-
Type of Failure		-	-	-	-
Appearance of Coating Surface		-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2/0.5VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS					
Plating Conditions	Specimen Number	W0-423-84-2	W0-423-84-3	W0-423-84-5	W0-423-84-27
	Dispersion Number	(3-B) 2-4A	(3-B) 2-4A	(3-B) 2-4A	(3-B) 2-4A
	Voltage	(100) 200	(100) 200	(100) 200	(100) 100
	Milliamps	(40) 100	(40) 100	(35) 45	(35) 45
	Time (Seconds)	(20) 120	(20) 150	(20) 180	(20) 155
Sintering	Coating Thickness (mils)	(1.0) 4.9	(1.0) 4.5	(1.0) 4.4	(1.0) 4.3
	Densification Press (psi)	(0) 10	(0) 10	(0) 10	(0) 10
	Temperature (°F)	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910
	Time (hours)	(1) 1	(1) 1	(1) 1	(1) 1
	Atmosphere	ARGON ARGON	ARGON ARGON	ARGON ARGON	ARGON ARGON
Silicizing	Temperature (°F)	2370	2370	2370	2370
	Time (hours)	8	8	8	8
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM
	Weight Gain (mgs/cm ²)	1.41	1.06	0.94	1.16
	Temperature (°F)	-	-	-	-
Preoxidation	Time (minutes)	-	-	-	-
	Atmosphere	-	-	-	-
	Weight Gain (mgs/cm ²)	-	-	-	-
	Number of Cycles	-	-	-	-
	Oxidation Life (hours)	-	-	-	-
1500°F	Type of Failure	-	-	-	-
	Appearance of Coating Surface	-	-	-	-
	Number of Cycles	82	7	9	7
	Oxidation Life (hours)	534	28	32	28
	Type of Failure	PATCH	EDGE	CORNER	EDGE
2400°F	Appearance of Coating Surface	SLIGHTLY GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY
	Number of Cycles	82	7	9	7
	Oxidation Life (hours)	534	28	32	28
	Type of Failure	PATCH	EDGE	CORNER	EDGE
	Appearance of Coating Surface	SLIGHTLY GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2/0.5VSi_2$

DATA IN PARENTHESIS REFER TO VS_{12}

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
Plating Conditions	Specimen Number	W0-423-84-33	W0-423-84-34	W0-423-84-35	W0-423-84-36	W0-423-84-37	
	Dispersion Number	(3-B) 2-4A	(3-B) 2-4A	(3-B) 2-4A	(3-B) 2-4A	(3-B) 2-4A	
	Voltage	(100) 100	(100) 100	(100) 100	(100) 100	(100) 100	
	Milliamps	(140) 60	(140) 60	(140) 60	(140) 60	(140) 60	
	Time (Seconds)	(30) 155	(20) 155	(20) 155	(20) 155	(20) 155	
	Coating Thickness (mils)	(1.0) 4.6	(1.0) 4.4	(1.0) 4.3	(1.0) 4.4	(1.0) 4.4	
	Densification Press (tsi)	(0) 10	(0) 10	(0) 10	(0) 10	(0) 10	
	Temperature (°F)	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910	
	Time (hours)	(1) 1	(1) 1	(1) 1	(1) 1	(1) 1	
	Atmosphere	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	
Silicizing	Temperature (°F)	2370	2370	2370	2370	2370	
	Time (hours)	8	8	8	8	8	
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	
Preoxidation	Weight Gain (mgs/cm ²)	1.15	0.76	0.65	0.61	1.55	
	Temperature (°F)	-	-	-	-	-	
	Time (minutes)	-	-	-	-	-	
1500°F	Atmosphere	-	-	-	-	-	
	Weight Gain (mgs/cm ²)	-	-	-	-	-	
	Number of Cycles	-	-	-	-	-	
	Oxidation Life (hours)	-	-	-	-	-	
	Type of Failure	-	-	-	-	-	
	Appearance of Coating Surface	-	-	-	-	-	
	Number of Cycles	9	7	7	7	12	
	Oxidation Life (hours)	32	28	28	28	52	
	Type of Failure	CORNER SURFACE	CORNER	EDGE	EDGE	CORNER	
	Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	Non-GLASSY	Non-GLASSY	
2400°F	Temperature (°F)	2400	2400	2400	2400	2400	
	Time (hours)	8	8	8	8	8	
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2/0.5VSi_2$

DATA IN PARENTHESIS REFER TO VS_i_2

COATING PROCESS PARAMETERS		W6-423-88-15	W6-423-88-16	W6-423-88-20	W6-423-88-21	W6-423-88-30
COATING TEST RESULTS	Specimen Number	(3-B) 2-4C (100)	(3-B) 2-4C (100)	(3-B) 2-4C (100)	(3-B) 2-4C (100)	(3-B) 2-4C (100)
	Dispersion Number	200	200	200	200	200
	Voltage	(40)	(40)	(40)	(40)	(40)
	Milliamps	40	40	40	40	40
	Time (Seconds)	(30)	(30)	(30)	(30)	(30)
	Coating Thickness (mils)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)
	Densification Press (psi)	3.0	3.0	3.0	3.0	3.0
	Temperature (°F)	(0)	(0)	(0)	(0)	(0)
	Time (hours)	10	10	10	10	10
	Atmosphere	(2910) 2910 (1)	(2910) 2910 (1)	(2910) 2910 (1)	(2910) 2910 (1)	(2910) 2910 (1)
Preoxidation	Time (hours)	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON
	Temperature (°F)	2370	2370	2370	2370	2370
	Time (hours)	8	8	8	8	8
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
	Weight Gain (mgs/cm ²)	3.59	0.09	1.15	0.78	0.61
	Temperature (°F)	2910	2910	2910	2910	2910
	Time (minutes)	3	3	3	3	3
	Atmosphere	AIR	AIR	AIR	AIR	AIR
	Weight Gain (mgs/cm ²)	-	-	-	-	-
	Number of Cycles	2	2	2	2	2
OXIDATION TEST RESULTS	Oxidation Life (hours)	4	4	4	4	4
	Type of Failure	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL
	Appearance of Coating Surface	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY	NON-GLASSY
	Number of Cycles	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-
	Type of Failure	-	-	-	-	-
	Appearance of Coating Surface	-	-	-	-	-
	Number of Cycles	-	-	-	-	-
	Oxidation Life (hours)	-	-	-	-	-
	Type of Failure	-	-	-	-	-

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-20TiSi_2/0.5VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
Plating Conditions	Specimen Number	W6-423-88-5	W6-423-88-7	W6-423-88-9	W6-423-88-10	W6-423-88-11	
	Dispersion Number	(3-8) 2-4C (100)	(3-8) 2-4C (100)	(3-8) 2-4C (100)	(3-8) 2-4C (100)	(3-8) 2-4C (100)	
	Voltage	200 (40)	200 (40)	200 (40)	200 (40)	200 (40)	
	Milliamps	30 (20)	40 (20)	40 (20)	40 (20)	40 (20)	
	Time (Seconds)	45 (1.0)	40 (1.0)	40 (1.0)	40 (1.0)	40 (1.0)	
	Coating Thickness (mils)	3.0 (0)	3.0 (0)	3.0 (0)	3.0 (0)	3.0 (0)	
	Densification Press (psi)	10 (2910)	10 (2910)	10 (2910)	10 (2910)	10 (2910)	
	Temperature (°F)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	
	Time (hours)	1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)	
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	
Sintering	Temperature (°F)	2370	2370	2370	2370	2370	
	Time (hours)	8	8	8	8	8	
	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	
	Weight Gain (mgs/cm ²)	0.58	0.55	0.51	0.62	0.86	
Preoxidation	Temperature (°F)	2910	2910	2910	2910	2910	
	Time (minutes)	3	3	3	3	3	
	Atmosphere	AIR	AIR	AIR	AIR	AIR	
	Weight Gain (mgs/cm ²)	-	-	-	-	-	
1500°F	Number of Cycles	2	2	2	2	2	
	Oxidation Life (hours)	4	4	4	4	4	
	Type of Failure	GENERAL	GENERAL	GENERAL	GENERAL	GENERAL	
	Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	Non-GLASSY	Non-GLASSY	
	Number of Cycles	-	-	-	-	-	
	Oxidation Life (hours)	-	-	-	-	-	
2400°F	Type of Failure	-	-	-	-	-	
	Appearance of Coating Surface	-	-	-	-	-	

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2$ -20TSSi₂/05 VS₂

DATA IN PARENTHESIS REFER TO VS₂

COATING PROCESS PARAMETERS		Plating Conditions				
Specimen Number		W0-423-88-1	W0-423-88-2	W0-423-88-8	W0-423-88-11	W0-423-88-12
Dispersion Number		(3-8) 2-4C	(3-8) 2-4C	(3-8) 2-4C	(3-8) 2-4C	(3-8) 2-4C
Voltage		(100) 200	(100) 200	(100) 200	(100) 200	(100) 200
Milliamps		(40) 30	(40) 30	(40) 40	(40) 40	(40) 40
Time (Seconds)		(20) 45	(20) 45	(20) 40	(20) 40	(20) 40
Coating Thickness (mils)		(10) 30	(10) 30	(10) 30	(10) 30	(10) 30
Densification Press (tsi)		(0) 10	(0) 10	(0) 10	(0) 10	(0) 10
Temperature (°F)		(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910
Time (hours)		(1) 1	(1) 1	(1) 1	(1) 1	(1) 1
Atmosphere		(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON
Temperature (°F)		2370	2370	2370	2370	2370
Time (hours)		8	8	8	8	8
Atmosphere		VACUUM	VACUUM	VACUUM	VACUUM	VACUUM
Weight Gain (mgs/cm ²)		0.56	0.77	0.54	0.54	0.51
Temperature (°F)		2910	2910	2910	2910	2910
Time (minutes)		3	3	3	3	3
Atmosphere		AIR	AIR	AIR	AIR	AIR
Weight Gain (mgs/cm ²)		-	-	-	-	-
Number of Cycles		-	-	-	-	-
Oxidation Life (hours)		-	-	-	-	-
Type of Failure		-	-	-	-	-
Appearance of Coating Surface		-	-	-	-	-
Number of Cycles		7	3	27	27	7
Oxidation Life (hours)		14	6	158	158	14
Type of Failure		SURFACE, PORE	CORNERS	SURFACE	EDGE	CORNER
Appearance of Coating Surface		Non-Glassy	Non-Glassy	Slightly Glassy	Slightly Glassy	Slightly Glassy

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MO_2Si_2-20TiSi_2/10.5VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS		Plating Conditions				Oxidation Test Results			
	Specimen Number	W6-423-88-13		W6-423-88-17		W6-423-88-18		W6-423-88-19	
		(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON	(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON	(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON	(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON	(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON	(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON	(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON	(3-B) 2-4C (100) 200 (40) 40 (20) 40 (10) 3.0 (0) 10 (2910) 2910 (1) (1) (ARGON) ARGON
COATING PROCESS PARAMETERS	Dispersion Number								
	Voltage								
	Milliamps								
	Time (Seconds)								
	Coating Thickness (mils)								
	Densification Press (tsi)								
	Temperature (°F)								
	Time (hours)								
	Atmosphere								
	Temperature (°F)								
Oxidation Test Results	Time (hours)								
	Atmosphere								
	Temperature (°F)								
	Time (hours)								
	Atmosphere								
	Weight Gain (mgs/cm ²)								
	Temperature (°F)								
	Time (minutes)								
	Atmosphere								
	Weight Gain (mgs/cm ²)								
Oxidation Test Results	Number of Cycles								
	Oxidation Life (hours)								
	Type of Failure								
	Appearance of Coating Surface								
	Number of Cycles								
	Oxidation Life (hours)								
	Type of Failure								
	Appearance of Coating Surface								
	Number of Cycles								
	Oxidation Life (hours)								

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-40CrSi_2/1.5VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS		W6-423-86-6	W6-423-86-12	W6-423-86-15	W6-423-86-17	W6-423-86-18
COATING TEST RESULTS	Plating Conditions	Specimen Number	(3-8) 2-5°C	(3-8) 2-5°C	(3-8) 2-5°C	(3-8) 2-5°C
		Dispersion Number	(100)	(100)	(100)	(100)
		Voltage	150	150	150	150
		Milliamps	(40) 40	(40) 40	(45) 50	(45) 50
		Time (Seconds)	(90) 45	(90) 45	(90) 45	(90) 45
		Coating Thickness (mils)	(3.0) 3.4	(3.0) 3.2	(3.0) 3.0	(3.0) 3.3
		Densification Press (psi)	(0) 10	(0) 10	(0) 10	(0) 10
		Temperature (°F)	(2910) 2910	(2910) 2910	(2910) 2910	(2910) 2910
		Time (hours)	(1) 1	(1) 1	(1) 1	(1) 1
		Atmosphere	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON	(ARGON) ARGON
Preoxidation	Silicizing	Temperature (°F)	2370	2370	2370	2370
		Time (hours)	8	8	8	8
		Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM
		Weight Gain (mgs/cm ²)	0.29	0.48	0.39	0.41
		Temperature (°F)	-	-	-	-
		Time (minutes)	-	-	-	-
		Atmosphere	-	-	-	-
		Weight Gain (mgs/cm ²)	-	-	-	-
		Number of Cycles	-	-	-	-
		Oxidation Life (hours)	-	-	-	-
2400°F	1500°F	Type of Failure	-	-	-	-
		Appearance of Coating Surface	-	-	-	-
		Number of Cycles	91	91	91	12
		Oxidation Life (hours)	626	626	626	52
		Type of Failure	STILL INTACT	STILL INTACT	STILL INTACT	CORNER
		Appearance of Coating Surface	SLIGHTLY GLASSY	SLIGHTLY GLASSY	NON-GLASSY	NON-GLASSY

PROCESSING PARAMETERS AND OXIDATION TEST RESULTS
OF SILICIDE COATED T-222 SPECIMENS

COATING: $MoSi_2-40CrSi_2/1.5 VSi_2$

DATA IN PARENTHESIS REFER TO VSi_2

COATING PROCESS PARAMETERS				OXIDATION TEST RESULTS			
Plating Conditions	Specimen Number	W0-423-86-2	W0-423-86-3	W0-423-86-5	W0-423-86-14	W0-423-86-16	
	Dispersion Number	(3-B) 2-5C (100)	(3-B) 2-5C (100)	(3-B) 2-5C (100)	(3-B) 2-5C (100)	(3-B) 2-5C (100)	
	Voltage	150 (40)	150 (40)	150 (40)	150 (40)	150 (40)	
	Milliamps	30 (90)	30 (90)	30 (90)	45 (90)	50 (90)	
	Time (Seconds)	40 (3.0)	40 (3.2)	40 (3.0)	45 (3.0)	45 (3.0)	
	Coating Thickness (mils)	3.0 (0)	3.0 (0)	3.1 (0)	3.3 (0)	3.3 (0)	
	Densification Press (psi)	10 (2910)	10 (2910)	10 (2910)	10 (2910)	10 (2910)	
	Temperature (°F)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	2910 (1)	
	Time (hours)	1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)	1 (ARGON)	
	Atmosphere	ARGON	ARGON	ARGON	ARGON	ARGON	
Sintering	Temperature (°F)	2370	2370	2370	2370	2370	
	Time (hours)	8	8	8	8	8	
Silicizing	Atmosphere	VACUUM	VACUUM	VACUUM	VACUUM	VACUUM	
	Weight Gain (mgs/cm ²)	0.35	0.29	0.33	0.45	0.33	
Preoxidation	Temperature (°F)	-	-	-	-	-	
	Time (minutes)	-	-	-	-	-	
	Atmosphere	-	-	-	-	-	
	Weight Gain (mgs/cm ²)	-	-	-	-	-	
	Number of Cycles	91	91	91	91	82	
1500°F	Oxidation Life (hours)	626	626	626	626	532	
	Type of Failure	STILL INTACT	STILL INTACT	STILL INTACT	STILL INTACT	EDGE	
	Appearance of Coating Surface	Non-GLASSY	Non-GLASSY	Non-GLASSY	Non-GLASSY	Non-GLASSY	
2400°F	Number of Cycles	-	-	-	-	-	
	Oxidation Life (hours)	-	-	-	-	-	
	Type of Failure	-	-	-	-	-	
	Appearance of Coating Surface	-	-	-	-	-	

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